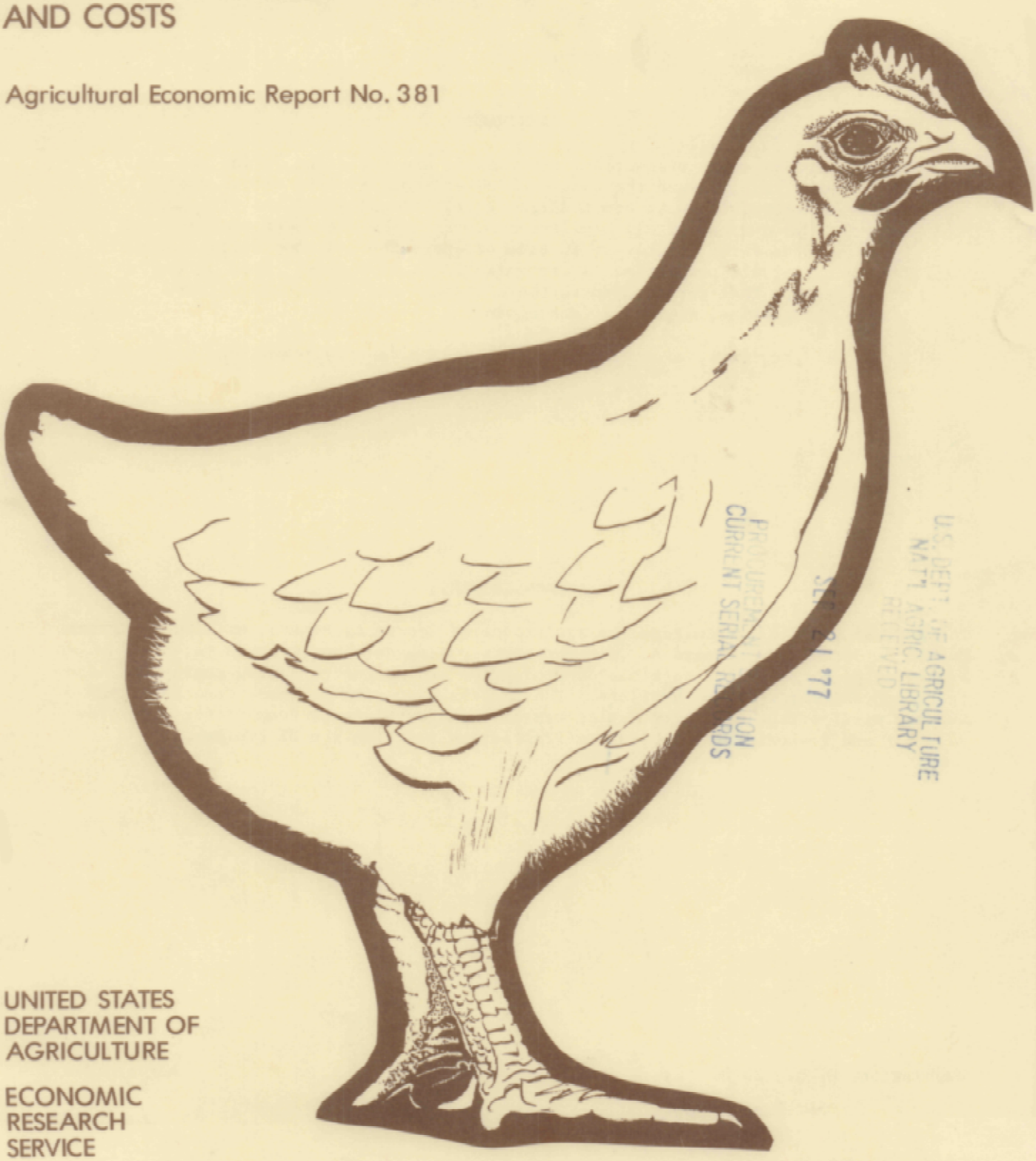
THE CHICKEN BROILER INDUSTRY:

STRUCTURE, PRACTICES, AND COSTS

Agricultural Economic Report No. 381



UNITED STATES
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THE CHICKEN BROILER INDUSTRY: STRUCTURE, PRACTICES, AND COSTS. By Verel W. Benson and Thomas J. Witzig, Commodity Economics Division, Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 381. This report updates "The Chicken Broiler Industry: Structure, Practices, and Costs," Marketing Research Report No. 930, published in May 1971.

ABSTRACT

Extensive changes in production, processing, and marketing during the last few decades have changed the chicken broiler industry from one of small, widely scattered farms to one that is large, concentrated, and efficient. More than 99 percent of all broilers produced are grown under contract and by integrated firms which vary in size of operation and complexity. About 84 percent of all production is concentrated in 10 States. Some of the other factors that contributed to these changes are costs, energy use, prices, processing, marketing, and demand.

Keywords: Broilers, consumption, costs, demand, energy, marketing, processing.

ACKNOWLEDGMENTS

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Washington, D. C. 20250 August 1977

CONTENTS

SUMMARY

Per capita consumption of broilers is expected to continue to rise, possibly to 46 pounds by 1985. It was 40.4 pounds in 1976, up from only half a pound in 1934. Per capita consumption of red meats increased from 144 pounds to 193 pounds over the same period.

In 1976, gross farm income from broilers was $2,951 million, 2.9 percent of the total realized gross farm income. This compares with $19 million in 1934, when the broiler share was only 0.2 percent.

Concentration and efficiency of the U.S. broiler industry have also grown steadily since the midthirties. Vertical coordination, the linking together of successive stages of production and marketing through ownership or contracting, has spread rapidly. Virtually all commercial broilers are now grown under contract or by integrated firms.

Arkansas, Georgia, Alabama, and North Carolina in that order, ranked highest in production in 1976. Fifty-nine percent of all broilers were produced on farms raising 100,000 or more birds per year, according to the 1969 Census of Agriculture. California, Mississippi, Maine, Maryland, and Delaware had the highest percentages of production from farms of this size. Twenty-two percent of all broilers were raised on farms producing 60,000 to 99,999 birds per year, and 15 percent were raised on farms producing 30,000 to 59,999 birds per year.

Broiler production costs for 1970-76 varied from 14.2 to 21.3 cents per pound with an average net return to farmers of 1.07 cents per pound. Feed costs made up about 72 percent of the total costs, chicks about 14 percent, and grower payments about 10 percent. Fuel, medication, litter, and other expenses made up the remaining 4 percent. Increasing energy prices and potential shortages have encouraged energy conservation by growers.

Prices to retailers are higher in Boston, New York, and Baltimore than in Atlanta and are higher on the west coast than in the East or Midwest. The variance generally reflects added costs for transporting and handling as distance from surplus-production areas increases. Retail prices in the northeast and on the west coast are somewhat higher than in the rest of the country.

The number of processing plants under Federal inspection slaughtering predominantly young chickens dropped from 288 in 1961 to 233 in 1976. However, during this period, the volume of broilers slaughtered increased from 6 billion pounds to 12 billion pounds live weight. The average slaughter of young chickens per plant increased from 2.6 million pounds in 1962 to 53.0 million pounds in 1976. All major regions gained in volume of slaughter during 1970-76. Seasonal variation in slaughter has decreased in recent years. Average monthly slaughter varied from 88 to 108 percent of the annual monthly average. The high months were May through October and the low months, November through April.

Cost per unit of output for broiler assembly, processing, and distribution is largely determined by grower location, plant size, utilization of plant capacity, and distance to final markets. Increased density of production areas, increased mechanization, realization of economies of scale by larger plants, and higher utilization of plant capacity reduced per unit costs through the midsixties. In recent years, however, increasing factor prices have more than offset these efficiencies. Thus, costs per unit have risen.

Further processing, military requirements, and exports accounted for over 9 percent of output in 1976. The percentage of volume as well as the actual quantities used for further processing and export have increased since 1969, and the percentage and quantity used by the military have decreased.

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by

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INTRODUCTION

Broilers are young chickens 7 to 10 weeks of age. Annual broiler production in the United States has increased from 34 million birds in 1934 to over 3.2 billion in 1976. Per capita consumption of broilers has increased from 0.5 pound per year in 1934 to 40.4 pounds in 1976. These tremendous increases in production and consumption are the result of new production and marketing technologies, changes in the economic structure of the industry, and a general rise in real per capita disposable income.

Since the thirties, the broiler industry has gradually changed from an industry characterized by many small, independent farm flocks and small processors scattered across the country to a highly integrated, efficient industry located in a relatively few counties. The major production areas are the northwestern corner of Arkansas; northern Georgia and Alabama; central Mississippi; eastern Texas; southern Maine; the Delmarva Peninsula of Maryland, Delaware, and Virginia; central North Carolina; and central California (fig. 1).

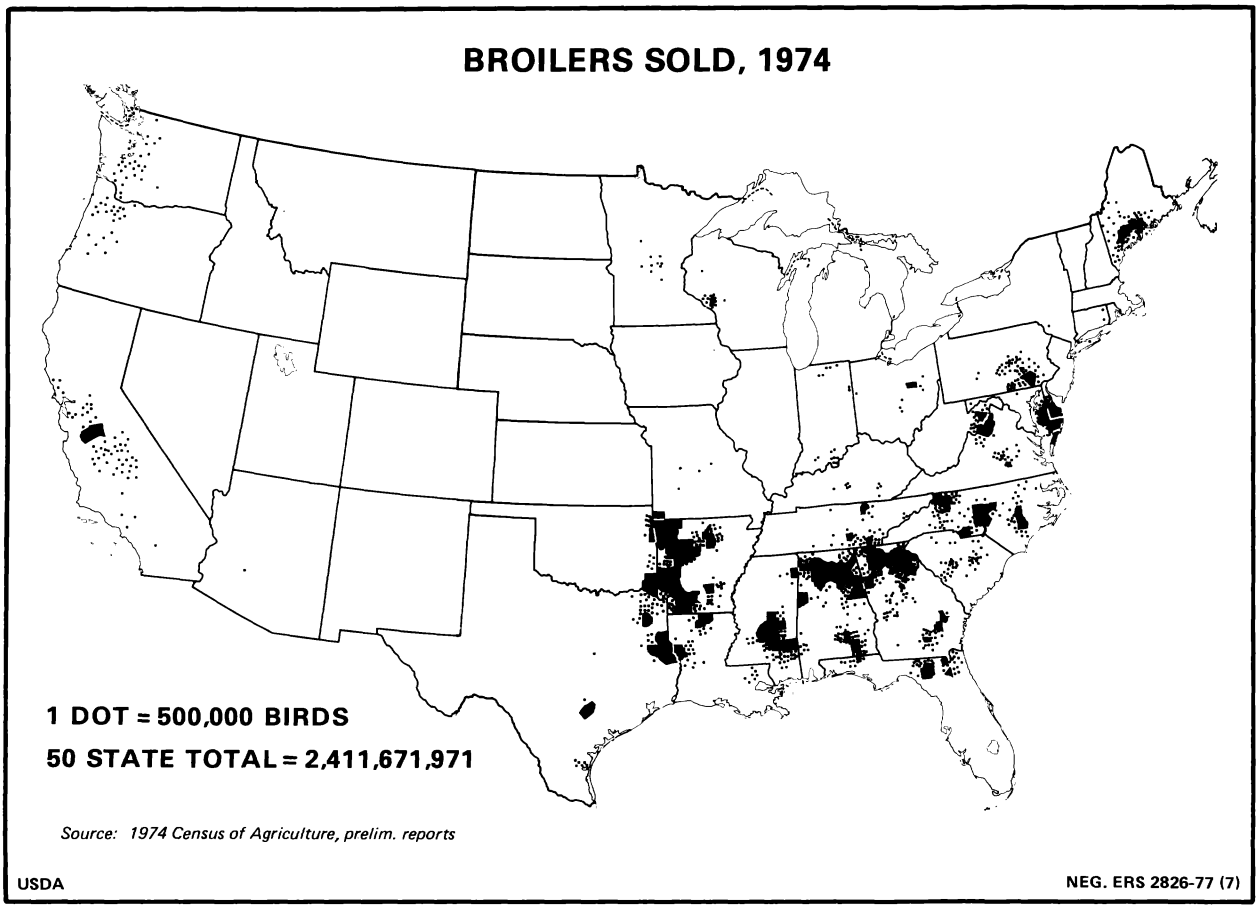


Figure 1

The broiler industry has also experienced extensive vertical and horizontal integration. A typical unit might consist of hatchery, feed mill, processing plant, a field service and management staff, and 150-300 contract growers. Figure 2 illustrates the functional framework of an integrated broiler production unit. Not all firms are as fully integrated as the illustration suggests, but virtually all firms have combined two or more of the major functions. The firm may be local, a subsidiary of a national feed company or meatpacker, or part of a large conglomerate corporation. Some firms are integrated horizontally because they include more than one processing plant, feed mill, or hatchery, often in different States.

Advances in production technologies, through genetic research and development, improvements in poultry nutrition, and improved management practices have enabled the broiler industry to produce a 3.5-pound broiler in 7 to 8 weeks, instead of the 12 to 14 weeks of 25 years ago, with a feed conversion of 2.1 pounds of feed per pound of live broiler compared to 4 pounds in 1940. The industry has been able to hold down or decrease many production and marketing costs because of economies of scale gained in processing and other activities associated with large integrated firms, as well as improved efficiency in broiler production. Although there are still new technologies being developed, their potential impact on the broiler industry is likely to be much less dramatic than those of the past 30 years. The cost of production and marketing may be further reduced by developments such as the use of poultry waste as a feed product, improved management practices and equipment to conserve energy, new preservation methods for poultry meat, further genetic improvements, and improved disease control. However, the increasing prices of feed, fuel, packaging, labor, and other inputs may offset any production or marketing cost reductions.

PRODUCTION

Output

In 1934, 34 million broilers were raised. Broiler production had jumped to 1.1 billion birds by 1954, to 2.0 billion by 1962, and to 3.2 billion birds by 1976 (table 1).

Ten Leading Producing States

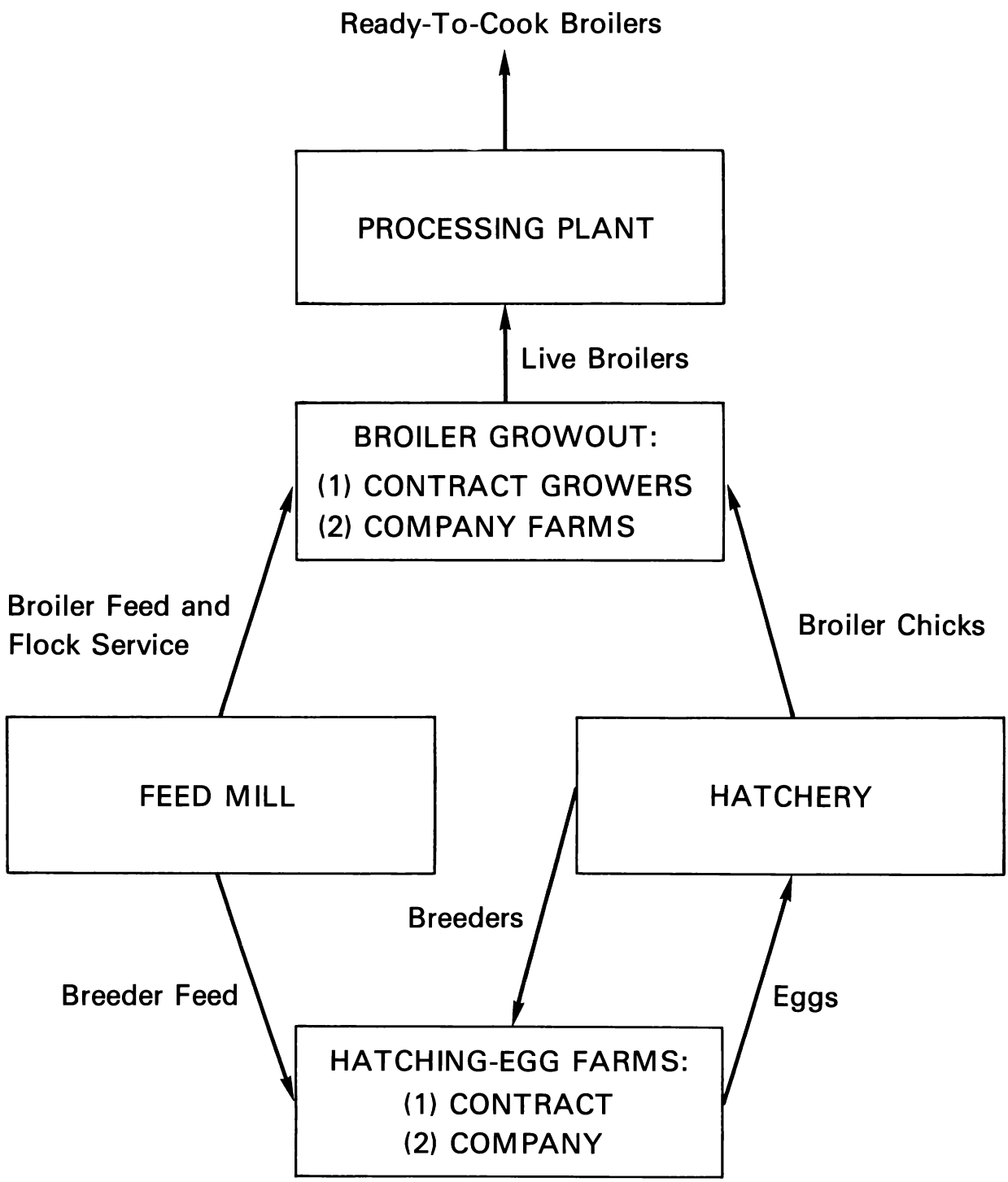
The ten States leading in broiler production in 1976 were Arkansas, Georgia, Alabama, North Carolina, Mississippi, Maryland, Texas, Delaware, California, and Virginia, in that order. These States have accounted for about 84 percent of U.S. total production in recent years. During the last 6 years, total production in these States had remained relatively stable until 1976 when all ten States experienced significant increases in production (table 2).

Output Per Farm

The number of U.S. farms producing broilers and other meat-type chickens dropped from about 42,000 in 1959 to about 33,000 in 1974, while output increased from around 1.4 billion to around 2.4 billion birds. Thus, average output per farm increased from 33,600 birds in 1959 to 72,400 birds in 1974 (table 3).

Since average prices received by producers trended downward from 1949 until the early seventies, increases in the value of production were usually attributed to increases in the total weight produced. However, prices increased dramatically in 1973 and have remained at the higher level (table 1).

FUNCTIONS OF A TYPICAL INTEGRATED BROILER FIRM



USDA

NEG. ERS 8235-77 (7)

Figure 2

Table 1--Broiler production, live weight, price per pound, value, and civilian per capita consumption, 1934-76 1/

Year	Production 2/			Average price received by producers per pound 3/	Value of production	Civilian per capita consumption
	Number	Live weight	Pounds produced as percentage of preceding year			
	Millions	Million pounds	Percent	Cents	Million dollars	Pounds
1934	34	97	---	19.3	19	0.5
1935	43	123	126.8	20.0	25	.7
1936	53	152	123.6	20.6	31	.8
1937	68	196	128.9	21.4	42	1.1
1938	82	239	121.9	19.0	46	1.3
1939	106	306	128.0	17.0	52	1.6
1940	143	413	135.0	17.3	72	2.0
1941	192	559	135.4	18.4	103	2.8
1942	228	674	120.6	22.9	155	3.2
1943	285	833	123.6	28.6	238	4.1
1944	274	818	98.2	28.8	235	3.9
1945	366	1,107	135.3	29.5	327	5.0
1946	293	884	79.9	32.7	289	4.1
1947	310	936	105.9	32.3	302	4.3
1948	371	1,127	120.4	36.0	405	5.5
1949	513	1,570	139.3	28.2	443	7.1
1950	631	1,945	123.9	27.4	533	8.7
1951	789	2,415	124.2	28.5	689	10.4
1952	861	2,624	108.7	28.8	756	11.7
1953	947	2,904	110.7	27.1	786	12.3
1954	1,048	3,236	111.4	23.1	747	13.7
1955	1,092	3,350	103.5	25.2	844	13.8
1956	1,344	4,270	127.5	19.6	838	17.3
1957	1,448	4,683	109.7	18.6	886	19.1
1958	1,660	5,431	116.0	18.5	1,002	22.0
1959	1,737	5,763	106.1	16.1	925	22.8
1960	1,795	6,017	104.4	16.9	1,014	23.4
1961	1,991	6,832	113.5	13.9	947	25.9
1962	2,023	6,907	101.1	15.2	1,049	25.8
1963	2,102	7,276	105.3	14.6	1,063	27.1
1964	2,161	7,521	103.4	14.2	1,070	27.7
1965	2,334	8,111	107.8	15.0	1,218	29.6
1966	2,571	8,989	110.8	15.3	1,372	32.0
1967	2,592	9,183	102.2	13.3	1,223	32.4
1968	2,619	9,326	101.6	14.2	1,326	32.8
1969	2,789	10,048	107.7	15.2	1,531	34.8
1970	2,987	10,819	107.7	13.6	1,475	36.9
1971	2,945	10,818	100.0	13.7	1,487	36.7
1972	3,075	11,480	106.1	14.1	1,623	38.4
1973	3,009	11,220	97.7	24.0	2,690	37.4
1974	2,993	11,322	100.9	21.5	2,436	37.5
1975	2,933	11,034	97.5	26.3	2,899	36.9
1976	3,280	12,506	113.3	23.6	2,951	40.4

1/ Includes Alaska and Hawaii beginning in 1961. 2/ Includes consumption in households of producers which is less than 1 percent of total production. 3/ Average based on Dec. 1 to Nov. 30 beginning in 1970.

Sources: Annual issues of Chicken and Eggs, Production, Disposition, Cash Receipts, and Gross Income, U.S. Dept. Agr., Stat. Rpt. Serv.

Table 2--Ten leading states in broiler production by rank for 1976

State	1971	1972	1973	1974	1975	1976	1971-76 average
				Million birds			
Arkansas	476	532	502	482	482	540	502
Georgia	431	443	413	427	417	452	431
Alabama	384	399	399	398	396	430	401
North Carolina	290	302	290	287	284	316	295
Mississippi	248	256	239	227	231	257	243
Maryland	181	177	191	190	180	199	186
Texas	172	179	173	174	163	191	175
Delaware	126	132	141	147	136	160	140
California	89	86	83	90	96	105	92
Virginia	71	77	77	77	78	89	78
10-State total	2,468	2,583	2,508	2,499	2,463	2,739	2,543
U.S. total	2,945	3,075	3,008	2,992	2,933	3,280	3,039
				Percent			
10 States share of U.S. total	84	84	83	84	84	84	84

Source: Annual issues of Chickens and Eggs, Production, Disposition, Cash Receipts, and Gross Income, U.S. Dept. Agr., Stat. Rpt. Serv.

Table 3--Farms producing broilers and other meat-type chickens, total birds sold, average sold per farm, 1959, 1964, 1969, and 1974, and percent distribution of flocks by size, United States and selected States, 1964 and 1969

Item and year	Maine	Md.	Del.	Calif.	N.C.	Ga.	Ala.	Miss.	Ark.	Tex.	10-State average	U.S. total
							Thousands					
Farms:												
1959	1.1	1.7	1.5	0.9	3.3	8.3	3.9	1.5	4.0	2.2	2.8	42.2
1964	.9	1.5	1.4	.4	3.3	7.4	4.5	1.7	4.1	1.9	2.7	35.1
1969	.6	1.5	1.1	.3	3.2	5.4	4.5	1.5	4.3	1.8	2.4	33.8
1974	.4	1.3	1.0	.3	2.2	3.3	3.6	1.3	4.0	1.4	1.9	33.3
							Millions					
Chickens sold:												
1959	49	79	72	45	104	225	141	89	150	80	103	1419
1964	59	116	108	53	173	307	211	151	268	124	157	1915
1969	60	151	113	68	252	374	335	176	368	156	205	2428
1974	63	153	121	95	212	330	315	172	422	143	202	2411
							Thousands					
Chickens per farm:												
1959	44	47	48	48	31	27	37	59	37	37	42	34
1964	65	77	76	134	53	42	47	90	66	65	72	55
1969	108	104	105	214	78	69	74	120	86	87	104	72
1974	166	113	123	275	94	100	88	128	104	103	107	72
							Percent					
Distribution of flocks: 1/												
1964:												
1-1.9	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/
2-3.9	.1	2/	2/	.1	.1	.1	.1	2/	2/	.1	.1	.1
4-7.9	.3	.2	.2	.3	.4	.8	.3	.2	.2	.4	.5	.5
8-15.9	1.2	1.3	1.4	4.6	2.4	4.7	2.3	.8	1.5	2.1	2.2	2.7
16-29.9	4.3	4.8	5.7	1.9	8.6	12.5	10.8	2.6	4.9	7.1	7.4	7.9
30-59.9	17.9	14.7	16.5	7.7	24.6	31.9	34.3	12.6	22.1	17.8	23.1	22.6
60-99.9	30.3	21.9	19.4	7.9	26.4	24.8	27.9	21.6	25.8	20.4	23.9	22.9
100 or more	45.9	57.1	56.8	77.5	37.5	25.2	24.3	62.2	45.5	52.1	42.8	43.3
1969												
1-1.9	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	.1
2-3.9	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/
4-7.9	2/	2/	2/	.1	.1	.1	.1	.1	.1	.1	.1	.1
8-15.9	.3	.3	.4	.3	.8	.8	.6	.4	.5	.7	.6	.8
16-29.9	1.2	1.7	2.1	1.0	2.7	3.7	.3	.6	1.5	2.7	2.4	2.7
30-59.9	8.1	9.7	10.8	3.1	15.9	21.6	23.2	6.4	15.1	12.2	15.5	15.4
60-99.9	16.2	17.9	19.4	4.1	26.1	29.0	26.2	13.7	26.0	20.8	23.2	22.2
100 or more	74.2	70.3	67.3	91.4	54.4	44.8	40.6	78.8	56.8	63.5	58.3	58.6

1/ 1,000 birds per flock.
2/ Less than one-tenth of 1 percent.

Sources: (57) and (58). Data for 1959 are estimated based on reports for a sample of farms.

Production Costs

Through the years, broiler production costs have probably averaged slightly lower than the average equivalent price at the farm level. As shown in table 1, prices declined from 36.0 cents a pound in 1948 to 13.6 cents per pound in 1970 and then rose to 23.6 cents per pound in 1976. Because production is usually a part of the total operation of an integrated firm, production costs include the inputs furnished by both the contract grower and the contractor. Average production cost estimates for the United States for 1955-76 are presented in table 4. The average, calculated from the net return series, indicates a positive net return of around 0.7 cent per pound live weight for 1955-76.

Only through substantial increases in production efficiency have broiler producers been able to maintain a generally positive net return over 1955-75. As mentioned above, improvements in broiler strains, as well as improved technology and production practices, have reduced the time needed to produce a 3.5-pound live bird from 12 to 14 weeks 25 years ago to 7 to 8 weeks now. Poultry nutritionists have developed feed

Table 4--Commercial broilers: Annual production costs, prices, and net returns at the farm, 1955-76

Year	Production costs 1/			U.S. farm price 2/	Net returns
	Feed	Other	Total		
	Cents per pound, live weight				
1955	13.1	7.4	20.5	25.2	+4.7
1956	12.3	6.7	19.0	19.6	+0.6
1957	11.9	6.3	18.2	18.9	+0.7
1958	11.6	6.0	17.6	18.5	+0.9
1959	11.0	5.7	16.7	16.1	-0.6
1960	10.3	5.4	15.7	16.9	+1.2
1961	10.0	5.1	15.1	13.9	-1.2
1962	9.9	4.9	14.8	15.2	+0.4
1963	10.1	4.7	14.8	14.6	-0.2
1964	10.0	4.5	14.5	14.2	-0.3
1965	9.8	4.7	14.5	15.0	+0.5
1966	9.8	4.9	14.7	15.3	+0.6
1967	9.1	5.0	14.1	13.3	-0.8
1968	8.4	5.1	13.5	14.2	+0.7
1969	8.5	5.3	13.8	15.2	+1.4
1970	8.8	5.4	14.2	13.5	-0.7
1971	9.0	5.3	14.3	13.8	-0.5
1972	9.0	5.3	14.3	14.3	0.0
1973	16.2	5.9	22.1	24.2	+2.1
1974	15.9	6.3	22.0	21.8	-0.2
1975	15.1	6.2	21.3	26.2	+4.9
1976	15.0	6.3	21.3	23.2	+1.9

1/ Estimated from various studies, 1955-66. Calculated by computerized monthly formula beginning in 1967, using studies and surveys.
2/ SRS series.

Source: (42)

formulations that have helped reduce the amount of feed needed to produce 1 pound of live broiler from 4 pounds in 1940 to 2.1 pounds today. Improvements in poultry housing, poultry feeding, and watering equipment have led to reduced labor requirements and better environmental control; that is, control of light, temperature, humidity, and air movement. These improvements in production facilities, feed formulations, broiler strains, and medicines and vaccines have improved growing efficiency and have reduced mortality from the 10 to 20 percent typical 25 years ago to today's 3 to 5 percent.

Actual costs per pound of broiler produced vary by geographic region and season. Table 5 presents the results of a recent study of broiler production costs in the southern, northeastern, and west coast regions of the United States. The percentage breakdown of total production costs is as follows:

	Percent
Feed	72.0-74.0
Chicks	12.3-16.1
Grower payment	8.4-11.7
Fuel	.8-1.5
Medication	.6-1.5
Litter	.1-.4
Other	.5-1.4

Direct comparison of the item-by-item cost for the three regions is difficult. The survey data did not cover the same proportions of the flocks in each quarter of the time periods, nor are the contract terms for the kinds and proportions of inputs furnished by the contractors or contract growers the same within or between regions. While similar kinds of contracts exist in each region, contractors in the Northeast and on the west coast, on the average, furnish higher proportions of fuel and litter than those in the South.

Because the areas were surveyed at different times, the data in table 5 should not be used to conclude that costs in the Northeast are necessarily equal to those in the South or that costs on the west coast are necessarily higher than those in either the Northeast or the South. There is also wide variation in flock sizes among the regions. However, grower payments do tend to average higher in the Northeast than in the South and west coast and lower on the west coast than in the other two regions. This is a function of the level of competition between broilers and other economic alternatives in various areas; the varying distance of producing areas from the major markets, which influence shipping costs; and price premiums for some northeastern broilers for heavier weights, differences in packs, or types of outlets serviced.

The surveys indicated that similar feed conversions existed in the three regions, despite lower live weights in the South. Fuel costs averaged highest in the Northeast, mainly because of climatic differences (24). 1/

The 1969 Census of Agriculture showed that nearly 59 percent of the broilers produced came from farms producing 100,000 birds or more, 22 percent from farms producing 60,000 to 99,999, and 15 percent from farms producing 30,000 to 59,999. Substantial increases in average output per farm were registered in all leading broiler areas from 1964 to 1969, and the 1974 Census should show a continuation of the trend. The largest outputs per farm in 1969 were in California, Mississippi, Maine, Maryland, and Delaware. The smallest outputs per farm that year were in Georgia and Alabama. In all States, except Georgia and Alabama, more than half the output came

1/ Numbers in parentheses refer to Selected References at the end of this report.

Table 5--Broiler production costs and efficiency, South, Northeast, and West Coast regions 1/

Item	South 2/ 1972-74	Northeast 3/ 1972-74	West Coast 1974-76
Sample characteristics:			
Farms (no.)	108	118	88
Flocks sold (no.)	415	592	396
Average liveweight (lbs./bird)	3.77	3.96	3.98
Feed conversion (lbs. feed/lb. broiler)	2.17	2.14	2.2
	Average cents per pound, salable live weight		
Production costs:			
Grower			
Fuel	0.14	4/0.09	0.06
Electricity	.07	.10	.11
Litter	.10	.03	.02
Hired labor	.15	5/.19	.10
Miscellaneous	6/.19	7/.02	.03
Total variable	.65	.43	.32
Depreciation	.43	8/.43	.47
Interest	.32	.21	.45
Insurance	.08	.08	.15
Repairs, maintenance	.11	.15	.13
Taxes	.05	.09	.15
Total fixed	.99	.96	1.35
Total grower	1.64	1.39	1.67
Contractor			
Feed	16.65	16.25	18.43
Chicks	2.80	2.77	4.13
Grower payment	2.30	2.63	2.15
Medication and vaccination	.24	9/.34	.20
Fuel	.14	.32	.39
Litter	.02	.10	.05
Other	10/.32	11/.11	.24
Total contractor	22.47	22.52	25.59

1/ Data collected by the Georgia, Pennsylvania, and Missouri Agricultural Experiment Stations under cooperative agreements with Econ. Res. Serv., U.S. Dept. of Agr. Records from mid-1972 to mid-1976. 2/ Includes Alabama, Georgia, North Carolina, Arkansas, Mississippi, Texas. 3/ Includes Pennsylvania, Maine, Delaware, Maryland, Virginia. 4/ Includes fuel use for manure and other waste disposal and fuel for heat. See also 5/. 5/ Unadjusted for payment in kind frequently associated with manure disposal. 6/ Includes water disposal, water, dues, and other costs. 7/ Includes sanitation, dues, and other miscellaneous costs. 8/ Includes rent. 9/ Includes services for sexing, debeaking. 10/ Includes administration, field supervision, insurance, and miscellaneous. Not all cost items included. 11/ Includes sanitation, electricity, dues, and other miscellaneous costs. May not completely include some small items.

Source: (26) and unpublished survey results.

from farms producing 100,000 or more broilers. California had a considerably greater percentage of production from the larger units than did the other States.

Seasonality

Broilers are grown in all seasons, although production costs and volume vary seasonally. One factor contributing to the variation in production costs is energy cost. The estimated energy use rates presented in table 6 were taken from a recent study of energy use in the poultry industry. Feed costs and other costs also vary seasonally; however, such variation has probably diminished with the adoption of environmentally controlled housing.

Seasonal variation in number and size of birds produced is related to seasonal variation in demand. Seasonal variation in production is best measured from data on slaughter of live birds by processing plants and is discussed more thoroughly in the section on processing.

Energy Use

Energy is used by the broiler industry in the form of propane, natural gas, fuel oil, and coal for brooding and space heating. Electrical energy is used for lighting,

Table 6--Examples of seasonal use of energy in different regions for broiler production, 1974

Month and item	Northern States: Semi- and environmentally controlled housing		Southern States: 10 percent environmentally controlled housing	
	Propane	Electricity	Propane	Electricity
	Monthly rate of use as a percent of average monthly rate			
January	204.0	99.0	219.3	92.0
February	178.0	94.0	180.5	83.0
March	153.7	90.0	151.7	78.0
April	95.5	88.0	81.5	78.0
May	55.4	91.0	52.3	90.0
June	30.6	101.0	19.9	110.0
July	19.5	118.0	8.5	140.0
August	24.3	122.0	12.5	135.0
September	42.2	104.0	35.3	115.0
October	77.0	99.0	80.1	98.0
November	130.3	96.0	146.9	90.0
December	189.6	98.0	211.3	91.0
	Gallons	Kilowatt hours	Gallons	Kilowatt hours
Annual amount used per 1,000	56.4	226	44.0	45

Source: (44)

ventilation, feeding, watering, and manure handling. Gasoline and diesel fuel are used for manure handling, feed hauling, bird hauling, and general farmwork. Estimated heating fuel use, electricity use, and gasoline and diesel fuel use for 1,000 broilers in 1974 are shown in table 7. The total energy use for all broilers in 1974 is estimated to be 122 million gallons of propane, 24 million therms 2/ of natural gas, 6 million gallons of fuel oil, 19,000 tons of coal, 6 million gallons of gasoline, and 504 million kilowatt hours of electricity.

In recent years, the rapid increase in fuel and electricity costs and potential energy shortages have resulted in increased interest in energy conservation in poultry production. Although energy costs still account for only a small part of the total production cost, the possibility of energy shortages has led to increased adoption of energy conservation measures by integrators and broiler growers. In the future, additional conservation measures and new sources of energy, such as solar energy, will undoubtedly be adopted by the industry as they become economically and technically feasible.

Value of Production

The average price received by producers for broilers fluctuated around 20 cents per pound in the thirties and early forties. Prices received by producers then began to increase, reaching a peak of 36 cents in 1948. In 1949, the price decreased 7.8 cents and continued to decline irregularly, reaching the 14- to 15-cent level in the midsixties (table 1). In 1967, it decreased to a record low of 13.3 cents per pound but has since increased. Since 1973, prices have averaged nearly 24 cents per pound.

With broiler production almost entirely under contract, farm prices, based on actual sales of live birds, have been gradually losing significance, although live-equivalent prices are used in many measures of farm output value and in statistical analyses. The farm-equivalent value of broilers produced in 1934 was $19 million. In 1958, this amount reached $1 billion. By 1976, the value of production was nearly $3 billion.

In recent years, the value of broiler manure and litter as a fertilizer or a feed ingredient has made production waste an additional source of income in many areas of the country. However, the potential market and the ease of marketing broiler manure varies considerably across the country.

Grower Contracts

Approximately 91 percent of all broilers are produced under contract. Integrator-owned farms produce about 8 percent, and independent production is probably less than 1 percent.

Contract broiler production is typically carried out by arrangements between an integrated firm (feed mixing, hatching, and processing plant) and a contract grower. The terms of these arrangements are changed infrequently and for various reasons, such as: changes in integrator returns from market sales, requirements for improved housing, increased energy prices, or grower location.

2/ A therm is that quantity of gas which, when burned, releases 100,000 Btu's of energy. A Btu is, in turn, the amount of energy needed to raise 1 pound of water from 62° to 63°F. Because of variations in pressure, temperature, and quality of gas, the therm, rather than volume, is used as a measure. One therm of average quality gas at 0°C and 14.2 lbs./in.^{2} has a volume of approximately 100 cu. ft.

Table 7--Rates of use of heating fuels, electricity, and gasoline and diesel fuel in broiler production, per 1,000 birds, U.S. average, 1974

Functions	Heating fuel 1/				Electricity	Gasoline and diesel fuel
	Propane	Natural gas	Fuel oil	Coal		
	Gallons	Therms	Gallons	Tons	Kilowatt hours	Gallons
Brooding and space heating	45.3	126.9	38.5	0.36	---	---
Lights	---	---	---	---	63	---
Ventilation	---	---	---	---	80	---
Other 2/	---	---	---	---	19	2.0
Total	45.3	126.9	38.5	.36	162	2.0
State ranges 3/	25-72	80-200	32-48	.28-.45	138-289	---

1/ Although heating is the major use for these fuels, small amounts of propane, natural gas, and fuel oil are used for incineration. Minor amounts are included for pumping water. Amounts listed are for a production cycle (growing a batch of broilers to market age). Use rates are not additive for a single operation. The proportions of total broiler production using the various heating fuels are: 86.9 percent propane; 6.1 percent natural gas; 5.4 percent fuel oil; and 1.7 percent coal.

2/ Other includes water, feeding, manure handling, farm hauling and general work, some feed hauling, and some bird hauling where performed by producers.

3/ State ranges reflect varying importance of various fuels by regions. Rates of use are mostly weighted averages of monthly volumes and rates.

Source: (44).

In most broiler-grower contracts, the integrator provides the chicks, feed, medication, field supervision, and sometimes fuel. The grower provides housing, litter, water, electricity, labor, and often fuel for heating and brooding.

A typical contract might specify a base price to be paid by the integrator per pound or per bird produced. A minimum bird weight may also be required. Premiums, based on the grower's efficiency (particularly feed efficiency) are then added to the base rate. The premium may be a fixed amount per point decrease in the feed conversion ratio or may be determined by a sliding scale with different premiums for different conversion ratios. In another type of contract, the premium is determined by the grower's ranking in efficiency among all the other growers producing for the firm.

Shortrun price risks are almost always assumed by the integrator. Multibatch or multiyear contracts can fix growing costs, but market conditions can vary the integrator's return.

In the long run, contract growers are affected by price risks, stemming both from market conditions and the financial well-being or goals of the integrated firms. When the market is depressed, integrators may try to reduce grower payments or, under certain types of contract terms, reprice the value of inputs they furnish. More frequently, the integrator will reduce the number of chicks placed per farm or lengthen the time between batches. Each of these practices reduces annual grower income. Ultimately, growers with the poorest performance records or those farthest away from processing plants could be dropped.

PROCESSING

Changes in Concentration

There has been a longrun trend toward greater concentration of broiler processing into fewer plants and fewer firms. However, this trend has tended to level off since 1964. The four largest broiler firms have processed virtually the same share of the federally inspected slaughter since 1964. The eight largest broiler firms processed approximately 3 percent more of the total in 1975 than in 1964. The 20 largest broiler firms processed about 11 percent more of the total in 1975 than in 1964. The number of plants owned by the 4 and 8 largest broiler firms decreased between 1964 and 1975, but the number owned by the 20 largest firms has increased by 9 plants since 1964 (table 8).

The exact number of firms processing broilers is not known, because of inadequate information on the ownership of broiler processing plants. It appears that the number of firms processing broilers decreased from approximately 201 in 1964 to about 154 in 1975. In 1964, 55 firms, 27 percent of the total, handled 70 percent of the volume. By 1975, 36 firms, 23 percent of the firms, handled 70 percent of the volume (table 9). Approximately 98 percent of all broilers slaughtered are now slaughtered under Federal inspection.

The functions performed and the degree of vertical integration varies among firms. A recent survey of broiler processing plants found that most firms assemble the broilers, slaughter, eviscerate, cut up, and deliver to retailers and institutions (table 10). Most firms surveyed also owned hatcheries and feed mills but contracted with growers for broiler production.

Table 8--Share of federally inspected young chickens slaughtered by the 4, 8, and 20 largest firms, and number of plants operated by these firms, 1964, 1972-75

Item and year	Four largest firms	Eight largest firms	Twenty largest firms
		Percent	
Share of federally inspected slaughter:			
1964	18	28	44
1972	17	29	43
1973	17	27	46
1974	17	28	50
1975	18	31	55
		Number	
Plants operated:			
1964	36	51	80
1972	25	47	80
1973	24	39	75
1974	28	44	93
1975	25	45	89

Product Form

Historically, broilers have been marketed in four forms: live, New York dressed, ready-to-cook, and as a part of further-processed products. Nearly 100 percent of all broilers are marketed as either ready-to-cook whole broilers, as cut-up whole birds or parts, or as further-processed products.

In 1960, 3.7 billion pounds of ready-to-cook young chickens were certified by Federal inspectors. By 1976, this amount had increased to nearly 9 billion pounds. Nearly 92 percent of these young chickens were packed as chilled birds. Frozen birds accounted for only 8 percent of the total poundage certified in 1976 (table 11). A recent survey of broiler processing plants in the South, Northeast, and west coast found that they marketed 92, 95, and 99 percent of their broilers chilled, respectively.

Young chickens inspected for cut up in 1976 accounted for 3,114 million pounds, or 35 percent of the total certified ready-to-cook birds. This is nearly five times the 662 million pounds inspected for cut up in 1962, the first year such data were published. Cut-up chickens accounted for 15 percent of the total certified in 1962.

Most of the remaining volume sold by processors is in the form of whole birds. In 1962, processors sold 83 percent of their birds as whole birds. In 1976, whole birds accounted for 5,230 million pounds, or 58 percent of the 8,987 million pounds certified. Subsequent handlers, including retailers, also cut up the young chickens.

Young chickens inspected for canning and further processing in 1976 totaled 643 million pounds, or over 7 percent of the total pounds certified (ready-to-cook

Table 9--Federally inspected firms processing young chickens and accounting for specified proportions of output, 1964, 1972-75

Percent of output	1964	1972	1973	1974	1975
			Number		
30	9	10	9	9	8
50	26	27	23	20	17
70	55	57	51	45	36
80	77	78	70	63	50
90	107	104	96	87	69
95	131	123	113	103	83
100	201	227	204	191	154

Table 10--Functions performed by firms with broiler packing plants, by regions, 1/

Item	South 1974	Northeast 1974	West coast 1973-75	Total 2/
		Number		
Plants surveyed	17	13	8	38
Plants which:				
Buy live or RTC	2	4	3	9
Assemble live	10	9	6	25
Slaughter, eviscerate	17	13	6	36
Cut up	15	10	8	33
Further process	2	6	4	12
Receive, warehouse, store	8	5	6	19
Long-distance haul	5	6	5	16
Deliver to retailers and institutions	10	11	8	29
Plants which are part of firms having:				
Hatcheries	17	8	3	28
Feed mills	17	9	3	29
Own production	3	10	6	19
Contract production	17	12	5	34

1/ Data collected in South by Georgia Agr. Exp. Sta., in the Northeast by Pennsylvania Agr. Exp. Sta., and in the West by Missouri Agr. Exp. Sta. under cooperative agreements with Econ. Res. Ser., U.S. Dept. Agr.

2/ A few may also have breeder flocks and be associated with rendering plants.

Table 11--Young chickens certified under Federal inspection, ready-to-cook weights by method of preservation, 1960-76

Year	Chilled	Frozen	Total
		Million pounds	
1960	3,382	317	3,699
1961	3,487	439	4,287
1962	3,865	496	4,361
1963	4,077	531	4,607
1964	4,244	566	4,810
1965	4,624	570	5,194
1966	4,976	628	5,604
1967	5,251	625	5,876
1968	5,326	613	5,939
1969	5,829	655	6,484
1970	6,436	725	7,161
1971	6,616	665	7,281
1972	7,140	683	7,823
1973	7,120	667	7,786
1974	7,300	617	7,917
1975	7,383	584	7,966
1976	8,255	732	8,987

Source: Various issues of Poultry Slaughtered Under Federal Inspection and Poultry Used in Further Processing, U.S. Dept. Agr., Stat. Rpt. Serv.

weight). This compares with 87 million pounds and 2 percent of total certified broilers in 1962 (table 12). A recent survey of 37 broiler processing plants in the South, Northeast, and west coast shows regional variation in product form. They marketed their broilers as whole, cut up, and further processed in the following proportions:

Product form	South 1974	Northeast 1974	West Coast 1973-75	Average
		Percent		
Whole	70	60	55	64
Cut up	26	34	41	31
Further processed	4	6	5	5

Table 12--Young chickens certified under Federal inspection, ready-to-cook weights by end use at the plant, 1960-76

Year	Whole birds 1/	Cut-up birds 2/	Further processing	Total
		Million pounds		
1960...	NA	NA	102	3,699
1961...	NA	NA	78	4,287
1962...	3,612	662	87	4,361
1963...	3,750	753	104	4,607
1964...	3,839	847	124	4,810
1965...	4,054	1,001	139	5,194
1966...	4,317	1,109	178	5,604
1967...	4,367	1,289	220	5,876
1968...	4,295	1,390	254	5,939
1969...	4,584	1,628	272	6,484
1970...	4,981	1,843	337	7,161
1971...	4,841	2,057	383	7,281
1972...	5,069	2,317	437	7,823
1973...	4,858	2,443	485	7,786
1974...	4,955	2,466	495	7,917
1975...	4,843	2,582	541	7,966
1976...	5,230	3,114	643	8,987

NA = not available.
1/ Calculated as a residual.
2/ Cut-up birds included in "further processing" totals in 1960 and 1961.

Source: Various issues of Poultry Slaughtered Under Federal Inspection and Poultry Used in Further Processing, U.S. Dept. Agr., Stat. Rpt. Serv.

Number, Size, and Location of Processing Plants

Poultry-processing plants under Federal inspection slaughter young chickens, mature chickens, turkeys, and other poultry. In recent years, poultry-processing plants have become more specialized. Approximately half of the plants that process broilers, process only broilers. The other plants still process mature chickens, turkeys, or other poultry as well.

For this study, all poultry-processing plants were classified according to the predominant market class that was slaughtered. According to this classification, 288 broiler plants slaughtered nearly 6 billion pounds (live weight) of young chickens in 1962, approximately 86 percent of the total slaughtered that year. They also slaughtered 252 million pounds of mature chickens and other poultry and 147 million pounds of turkeys. By 1970, the number of broiler plants had dropped to 246, but the volume of young chickens slaughtered had increased to 9 billion pounds, or about 94 percent of the total slaughtered. These 246 plants also slaughtered 216 million pounds of mature chickens and other poultry and 96 million pounds of turkeys. In 1976, the number of plants had dropped to 233 but the volume of young chickens slaughtered had increased to 12.3 billion pounds, approximately 99 percent of the total slaughtered in federally inspected plants. These plants also slaughtered 81 million pounds of mature chickens and other poultry and 82 million pounds of turkeys.

The average plant slaughtered approximately 20.8 million pounds of young chickens in 1962, 40.7 million pounds in 1970, and 53.0 million pounds in 1976.

All regions, except for the West North Central, showed increases in slaughter from 1970 to 1976. The largest increases were in the South Central and South Atlantic regions, which increased 0.9 and 1.4 billion pounds, respectively.

The number of plants in the two smallest size groups decreased and slaughter volume also dropped from 1970 to 1976 (table 13). Conversely, the number of plants in the largest-size group increased considerably, as did slaughter volume. In 1970, the largest-size group accounted for about 29 percent of all broiler processing plants and 54 percent of the broiler weight slaughtered. By 1976, they accounted for about 44 percent of the broiler processing plants and approximately 73 percent of the volume slaughtered. The locations of the 215 poultry plants under Federal inspection slaughtering predominantly young chickens in 1975 are shown in figure 3. With very few exceptions, the plants are located in broiler-producing areas. Areas of high plant density are also areas of high production density.

Seasonality

From 1971 to 1976, average monthly rates of slaughter in federally inspected plants varied from a low of 88 percent to a high of 108 percent of the annual monthly average (table 14). This is a reduction of seasonal variation from 1965-69 when the low was 82 percent and the high was 117 percent of the annual monthly average. The low months were November through April, and the high months were May through October. This seasonal variation is small compared to those of some other commodities.

Processing Costs and Income

A recent study of price spreads, costs, and productivity in poultry and egg marketing for 1955-74 examined changes in assembly, processing, and long-distance transportation costs in broiler marketing (43). Some of the conclusions are presented in the following sections and tables.

Assembly

Assembly costs per unit of output declined after the midfifties because of the declining average hauling distances between farms and processing plants, increased volumes per load, and increased density of production around processing plants. Gains in efficiency more than offset rising factor prices associated with assembly of broilers until the midsixties. Since then, factor prices and assembly costs have increased more rapidly than gains in efficiency. The assembly cost for 1955-75 and productivity indexes for selected periods during that time are presented in tables 15 and 16.

Total productivity in assembling broilers was substantially higher in 1965-69 than a decade earlier. Current productivity levels are above those of 1965-69. Since 1965-69, increased mechanization of broiler loading operations has resulted in increased labor productivity. Some further gains in productivity have also occurred because of larger producing units and increased density of supply areas. There were productivity gains from energy used in assembly, related to vehicle size and density of supply areas.

Table 13--Number of broiler slaughtering plants under Federal inspection and annual volume of young chickens slaughtered (live weight) by size of plant and region, 1970-76 1/

Year	Plants in size group by annual volume (1,000 lbs.)				Annual volume by size group			
	0 to 15,999 pounds	16,000 to 51,999 pounds	52,000 pounds and over	Total plants	0 to 15,999 pounds	16,000 to 51,000 pounds	52,000 pounds and over	Total volume
	Number				1,000 pounds			
1970:								
North Atlantic	10	8	6	24	55,473	240,505	386,099	682,077
E. North Central	6	4	0	10	23,626	93,904	0	117,530
W. North Central	7	5	2/	12	50,253	157,387	2/	207,640
South Atlantic	8	44	2/33	85	47,019	1,586,772	2/2,635,390	4,269,181
South Central	11	59	3/32	102	68,118	2,080,240	3/2,386,975	4,535,333
West	7	6	3/	13	67,042	133,622	3/	200,664
Total	49	126	71	246	311,531	4,292,430	5,408,464	10,012,425
1971:								
North Atlantic	10	7	7	24	42,415	190,383	442,299	675,097
E. North Central	9	5	0	14	17,559	106,894	0	124,453
W. North Central	6	5	2/	11	23,209	153,981	2/	177,190
South Atlantic	8	40	2/36	84	38,033	1,445,841	2/2,790,395	4,274,269
South Central	10	55	33	98	85,231	2,048,408	2,526,712	4,660,351
West	12	5	0	17	81,716	140,292	0	222,008
Total	55	117	76	248	288,163	4,085,799	5,759,406	10,133,368
1972:								
North Atlantic	10	6	7	23	33,725	169,581	448,984	652,290
E. North Central	8	4	0	12	22,982	99,723	0	122,705
W. North Central	9	5	2/	14	29,102	171,261	2/	200,363
South Atlantic	4	34	2/41	79	36,581	1,269,056	2/3,237,532	4,543,169
South Central	13	49	3/41	103	102,343	1,886,043	3/3,186,297	5,174,683
West	12	5	3/	17	63,025	116,238	3/	179,263
Total	56	103	89	248	287,758	3,711,902	6,872,813	10,872,473
1973:								
North Atlantic	9	7	6	22	37,706	213,457	400,078	651,241
E. North Central	4	4	0	8	21,250	106,192	0	127,442
W. North Central	9	5	2/	14	24,821	169,828	2/	194,649
South Atlantic	6	33	2/40	79	45,388	1,236,652	2/3,174,387	4,456,427
South Central	12	47	3/40	99	73,028	1,829,334	3/3,285,946	5,188,308
West	11	4	3/	15	89,039	106,732	3/	195,771
Total	51	100	86	237	291,232	3,662,195	6,860,411	10,813,838
1974:								
North Atlantic	10	6	6	22	41,181	201,423	410,118	652,722
E. North Central	4	3	0	7	17,026	100,067	0	117,093
W. North Central	9	3	3	15	25,762	91,079	201,586	318,427
South Atlantic	4	32	40	76	25,223	1,218,746	3,223,884	4,467,853
South Central	8	47	3/41	96	68,868	1,772,031	3/3,359,009	5,199,908
West	8	7	3/	15	50,129	163,787	3/	213,916
Total	43	98	90	231	228,189	3,547,133	7,194,597	10,969,919
1975:								
North Atlantic	9	5	7	21	43,259	143,519	470,189	656,967
E. North Central	3	3	0	6	19,053	108,546	0	127,599
W. North Central	5	4	2/	9	19,639	144,778	2/	164,417
South Atlantic	4/	30	2/40	70	4/	1,153,388	2/3,414,686	4,568,074
South Central	4/8	46	3/39	93	4/89,069	1,788,943	3/3,338,421	5,216,433
West	8	8	3/	16	45,778	172,024	3/	217,802
Total	33	96	86	215	216,798	3,511,198	7,223,296	10,951,292
1976:								
North Atlantic	7	7	7	21	25,445	196,806	497,586	719,837
E. North Central	3	3	0	6	19,427	117,956	0	137,383
W. North Central	6	4	2/	10	22,173	139,196	2/	161,369
South Atlantic	4/	24	2/47	71	4/	948,407	2/4,202,386	5,150,793
South Central	4/5	41	3/49	95	4/52,059	1,582,442	3/4,281,994	5,916,495
West	21	9	3/	30	60,571	213,773	3/	274,344
Total	42	88	103	233	179,675	3,198,580	8,981,966	12,360,221

1/ Slaughtering predominantly young chickens.
2/ Plants and volume for West North Central and South Atlantic regions have been combined to avoid disclosure of individual plant data.
3/ Plants and volume for South Central and Western regions have been combined to avoid disclosure of individual plant data.
4/ Plants and volume for South Atlantic and South Central regions have been combined to avoid disclosure of individual plant data.

Source: Comp. from unpubl. data, U.S. Dept. Agr., Animal and Plant Health Inspection Service.

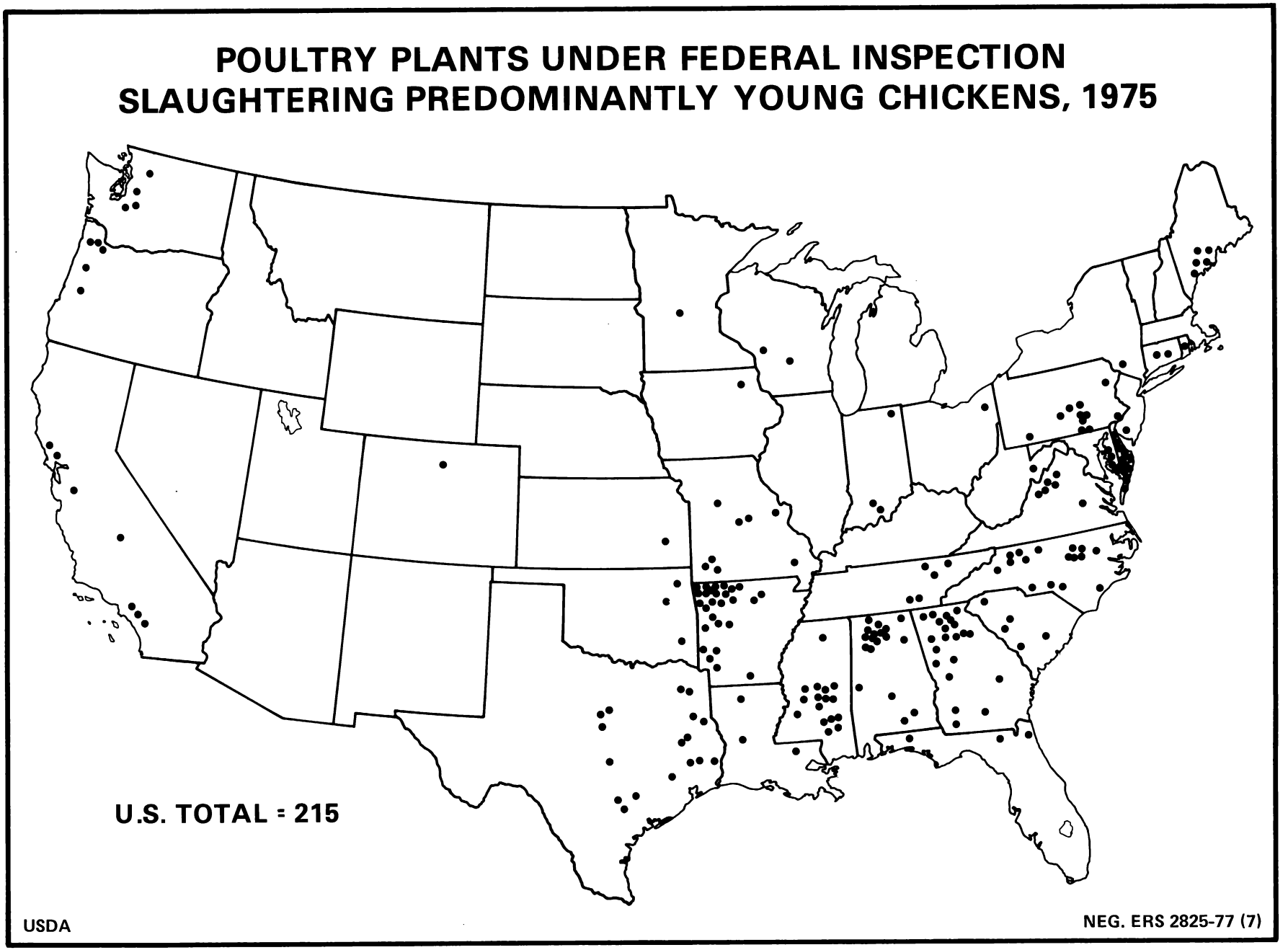

POULTRY PLANTS UNDER FEDERAL INSPECTION
SLAUGHTERING PREDOMINANTLY YOUNG CHICKENS, 1975
U.S. TOTAL = 215
USDA
NEG. ERS 2825-77 (7)

Figure 3

Table 14--Seasonality of slaughtering of young chickens, monthly 1971-76

Item and month	1971	1972	1973	1974	1975	1976	1971-76 average
				Million pounds 1/			
Monthly slaughter:							
January	563	616	662	713	646	712	652
February	530	596	566	601	570	632	583
March	617	653	621	642	617	772	654
April	599	624	594	672	688	743	653
May	592	715	712	745	690	745	700
June	654	713	680	687	683	826	707
July	619	637	674	720	714	766	688
August	674	738	704	714	681	805	719
September	631	636	610	621	685	800	664
October	625	695	733	687	740	770	708
November	576	618	642	525	561	699	604
December	601	582	588	590	691	717	628
Total	7,281	7,823	7,786	7,917	7,966	8,987	7,960
Annual monthly average	607	652	649	660	664	749	663
				Percent			
Annual monthly average							
January	93	95	102	108	97	95	98
February	87	91	87	91	86	84	88
March	102	100	96	97	93	103	99
April	99	96	91	102	104	99	98
May	97	110	110	113	104	99	106
June	108	109	105	104	103	110	107
July	102	98	104	109	107	102	104
August	111	113	109	108	103	107	108
September	104	97	94	94	103	107	100
October	103	107	113	104	111	103	107
November	95	95	99	79	85	93	91
December	99	89	91	89	104	96	95

1/ Certified ready-to-cook weight.

Source: Various issues of the Poultry and Egg Situation, U.S. Dept. Agr., Econ. Res. Serv.

Table 15--Processing costs for broilers, ready-to-cook, whole equivalent, 1955-75 1/

Year	Assembly	Processing	Long-distance transportation 2/	Total
		Cents per pound 3/		
1955	1.2	5.6	1.0	7.8
1956	1.2	5.4	1.0	7.6
1957	1.1	5.2	1.0	7.3
1958	1.0	5.0	1.0	7.0
1959	1.0	4.9	1.0	6.9
1960	.9	4.7	1.0	6.6
1961	.9	4.5	1.0	6.4
1962	.9	4.3	1.0	6.2
1963	.8	4.2	1.0	6.0
1964	.8	4.1	1.0	5.9
1965	.9	4.3	1.0	6.2
1966	.9	4.5	1.0	6.4
1967	.9	4.6	1.0	6.5
1968	.9	5.0	1.0	6.9
1969	1.0	5.3	1.0	7.3
1970	1.0	5.4	1.0	7.4
1971	1.0	5.7	1.0	7.7
1972	1.0	6.2	1.1	8.3
1973	1.2	6.7	1.1	9.0
1974	1.4	7.2	1.4	10.0
1975 4/	1.4	7.5	1.4	10.3

1/ Equivalent to market basket series totals.
2/ Weighted average of intraregional and interregional movements.
3/ Fresh ice packed and similar forms.
4/ Preliminary.

Source: (43)

Table 16--Productivity in broiler marketing by cost item and function, selected periods, 1955-74

(1965-67 = 100)

Cost item and function	1955-59	1960-64	1965-69	1970-73	1974 1/
Wages, salaries, fringe benefits:					
Assembly	63	93	100	112	111
Processing	48	89	100	98	107
Long-distance transportation	62	72	100	130	126
Containers, materials:					
Processing	90	91	100	113	119
Energy:					
Assembly	62	96	100	120	120
Processing	111	104	100	107	108
Long-distance transportation	80	91	100	110	119
Overhead:					
Assembly	75	95	100	111	102
Processing	113	109	100	98	98
Long-distance transportation	84	95	100	128	116
Other:					
Processing	143	114	100	98	99
Long-distance transportation	88	88	100	112	132
Total:					
Assembly	63	94	100	114	112
Processing	68	96	100	101	106
Long-distance transportation	79	89	100	123	119

1/ Preliminary.

Source: (43)

The proportion of assembly costs accounted for by the various cost categories is presented in table 17. Until recent years, labor and overhead costs accounted for a gradually increasing percentage of the assembly costs. However, rapidly increasing energy prices have reversed this trend and have increased the percentage of the assembly costs accounted for by energy.

Processing

Cost per unit of output for slaughtering and eviscerating broilers trended downward from the midfifties to the midsixties. Increased mechanization, realization of economies of scale by larger plants, and higher utilization of capacity produced efficiencies that were more than sufficient to offset rising factor prices. Although further gains in efficiency have occurred since the midsixties, they have not been sufficient to offset rising factor prices. Thus, costs per unit have risen (table 15).

Table 17--Proportions of broiler marketing costs by functions and cost items, selected periods, 1955-74

Function and cost item	1955-59	1960-64	1965-69	1970-73	1974 1/
			Percent		
Assembly:					
Wages, salaries, fringe benefits	64.4	67.7	70.3	72.2	66.5
Energy	31.8	27.9	25.2	23.1	29.1
Overhead	3.8	4.4	4.5	4.8	4.4
Total	100.0	100.0	100.0	100.0	100.0
Processing:					
Wages, salaries, fringe benefits	62.4	49.1	48.0	51.1	47.4
Containers, materials	15.0	18.7	16.4	13.2	14.1
Energy	5.3	7.2	6.8	6.3	8.9
Overhead	10.0	14.4	16.6	17.6	17.0
Other	7.3	10.6	12.2	11.7	12.6
Total	100.0	100.0	100.0	100.0	100.0
Long-distance transportation:					
Wages, salaries, fringe benefits	18.0	18.1	16.1	15.9	14.5
Energy	29.1	27.4	24.9	26.8	31.2
Overhead	49.6	51.3	55.9	54.1	51.8
Other	3.3	3.2	3.1	3.2	2.5
Total	100.0	100.0	100.0	100.0	100.0

1/ Preliminary.

Source: (43)

Substantial increases in total productivity occurred after the midfifties. New forms of equipment were added to broiler processing lines which curtailed labor needs. But labor productivity in broiler processing actually declined in the early seventies, when many plants experienced higher labor turnover and labor supply problems.

Gains in labor productivity in handling standard products in processing plants have been substantial over the last 15 years. However, overhead productivity has not shown this pattern because of the extensive substitution of equipment for labor. The shift of most packaging functions back toward the processing plant level has nullified productivity gains associated with the use of containers and materials in processing plants, but has raised productivity for the total marketing system. Energy productivity declined from the midfifties to late sixties because of the higher energy use by more mechanized equipment. Recently, energy productivity has increased because of economies of scale and new equipment.

The relative importance of various cost categories in the total processing cost picture for broilers has changed in recent years. Labor, still the major component of broiler processing costs, has declined from over 60 percent to under 50 percent of total costs since 1955. Increases in shares from 5 to 9 percent, 10 to 17 percent, and 7 to 12 percent have occurred for energy, overhead, and other costs, respectively. Container and material costs have declined to less than 15 percent.

Long-distance Transportation

Long-distance transportation costs have been affected by their exempt commodity status, by shifts in regional production patterns, the displacement of rail by truck movement, and adjustments where back-hauls were possible. However, transportation rates for broilers have remained steady into the seventies. Only recently have rising factor prices produced a clear upward pressure on costs.

Total productivity in long-distance transportation has shown an upward trend since the midfifties because of larger vehicles, reduced travel distances and travel time, and heavier gross and net loads. Upward trends in productivity have, on balance, been characteristic for all cost categories.

Overhead costs have accounted for half or more of total costs, and energy and labor costs for most of the remainder. The share of energy costs, which has accounted for a quarter to a third of the total costs, decreased from the midfifties to the late sixties, but has risen since that time.

Regional Assembly, Processing and Distribution Costs

A recent study estimated processing costs for the South, Northeast, and west coast (47). Records for 1973-75 from 33 broiler processing plants in three major U.S. regions showed total costs averaging almost 9.7 cents per pound, ready-to-cook weight (table 18). About 1.0 cent was for loading and hauling live broilers from farms to plants, 7.36 cents was for inplant costs, and 1.3 cents for assembly and distribution costs. Almost 58 percent of the inplant costs was for wages and salaries, over 17 percent for packaging materials, and over 15 percent for overhead costs.

Assembly costs were similar in most regions because most broiler processing plants obtain birds from supply areas of limited radius. Inplant costs averaged lowest in the South and highest on the west coast. Distribution costs varied widely within and among regions because of distances to major markets and relative proportions of output delivered to retail stores and warehouses.

Table 18--Broiler processing plant costs by major regions, selected years, 1973-75 1/

Item	South, 1973-74	Northeast, 1974	West coast, 1973-75
Plants (no.)	16	11	6
Volume (mil. lbs. RTC)	732	326	232
		Percent	
Product form:			
Whole	70	60	55
Cut up	26	34	44
Further processed	4	6	1
		Cents per pound, RTC weight	
Variable costs:			
Plant labor	3.25	3.97	3.87
Packaging	1.10	1.44	1.28
Utilities, fuel	.34	.56	.41
Management, office	.52	.49	.59
Miscellaneous	.21	.30	.37
Total	5.42	6.76	6.52
Fixed costs:			
Depreciation, rent	.33	.30	.87
Repairs, maintenance	.35	.20	.36
Taxes, interest, insurance	.34	.31	.32
Total	1.02	.81	1.55
Total variable and fixed costs.	6.44	7.57	8.07
Assembly costs	1.04	.96	1.00
Distribution costs	1.45	.86	1.70
Total all costs	8.93	9.39	10.77

1/ Costs do not include further-processing operations.

Source: (47)

The commercial broiler processing plants in the study sample were about average in size and accounted for about 17 percent of total slaughter. Some plants also had further-processing operations in addition to slaughtering, eviscerating, and cutting-up lines. For the plants in the sample, further processing accounted for only 3 to 4 percent of volume, compared with almost 62 percent sold in ready-to-cook whole form and over 34 percent in cut-up form.

Incomes

Estimated net returns to an integrated firm per pound of ready-to-cook broiler produced are presented in table 19. These net returns accrue to the entire integrated operation and, therefore, exceed those accruing to processing alone. They show the

Table 19--Commercial broilers: Annual marketing costs, prices, and net returns, 1955-75

Year	Plant cost 1/	Market cost 2/	Wholesale market price 3/	Net returns
	Cents per pound, ready-to-cook weight			
1955	27.9	35.7	41.5	+5.2
1956	26.4	34.0	34.7	+ .7
1957	25.3	32.6	33.0	+ .4
1958	24.4	31.4	32.1	+ .7
1959	23.2	30.1	29.0	- .9
1960	21.8	28.4	29.9	+1.5
1961	21.0	27.4	26.1	-1.3
1962	20.6	26.8	28.0	+1.2
1963	20.6	26.6	27.2	+ .6
1964	20.1	26.0	25.4	- .6
1965	20.1	26.3	26.4	+ .1
1966	20.4	26.8	27.6	+ .8
1967	19.7	26.2	25.2	-1.0
1968	18.8	25.7	27.2	+1.5
1969	19.2	26.5	29.1	+2.6
1970	19.7	27.1	26.4	- .7
1971	19.9	27.6	27.2	- .4
1972	19.9	28.2	28.2	.0
1973	30.8	39.8	42.4	+2.6
1974	30.1	40.1	38.0	-2.1
1975	29.2	39.5	45.2	+5.7

1/ Live production costs converted to ready-to-cook weight.
2/ Includes assembly, processing, and long-distance hauling.
3/ Based mainly on New York wholesale price, 1955-63. Based on 9-city weighted average wholesale price beginning with 1964.

Source: (42)

variability of industry income from year to year. However, over the entire 1955-75 period there was a positive estimated net return of nearly 0.8 cent per pound of ready-to-cook weight.

Processing Wastes and Pollution Control

Nearly all the offal and feathers and most of the blood from broiler processing are salvaged and rendered to be used as protein supplements in animal feeds. In 1976, nearly 3.5 billion pounds of byproducts resulted from processing operations. While most of this is salvaged, the unsalvaged blood, the processing wash water, and the water used to carry off the wastes still present a significant pollution problem. The method of handling byproducts generally determines the pollution potential of a processing plant.

A study by Vertrees in 1972 (60) concluded that current industry performance in byproduct handling and disposition is much better than it was 15 years ago. The study found that about 63 percent of poultry slaughtering plants 3/ used municipal facilities for final waste treatment, about 29 percent had private facilities, and only about 7 percent had no waste treatment. Some 14 percent used a combination of private and municipal facilities.

Of those processing plants with private treatment facilities, 63 percent used lagoons of some sort, about half of them combined aerobic-anaerobic systems, a type defined in the study as the best practicable technology. Thirteen percent used irrigation, 7 percent used extended aeration, and only a few used activated sludge systems. Fourteen percent had only primary treatment facilities. 4/ Extended aeration was defined as the best available control technology.

Average replacement values for private treatment facilities were estimated to range from $63,000 to $180,000 per plant in 1971. Operation and maintenance costs for private waste water treatment facilities in broiler plants were estimated to range from 0.7 to 1.9 percent of average total plant costs. Kerns and Jones (29) in 1974 concluded that for private treatment facilities "to meet the best available technology, total capital expenditures for equipment would increase from current levels of $10 to as much as $34 per 1,000 birds processed annually. Operational and maintenance costs would increase from $0.90 per 1,000 birds processed annually at present to $5 per 1,000 in future years."

Losses

Condemnation Loss in Processing Plants

When young chickens are brought to the processing plants, they are inspected twice. Inspection of live birds is known as ante-mortem inspection. Examination of carcasses and entrails after slaughter is known as post-mortem inspection.

Post-mortem condemnations are mainly due to diseases or infections such as leukosis, septicemia, air saculitis, synovitis, and tumors. Other causes are bruises, cadavers (death prior to slaughter), contamination, and overscald.

In 1976, 12.44 billion pounds of live, young chickens were inspected at processing plants under Federal inspection, and 37 million pounds or 0.3 percent were condemned ante-mortem. The ante-mortem condemnation rate rose from a low of 0.2 percent in the early sixties to a high of 0.5 percent in the early seventies; in 1975, it declined to 0.3 percent.

In order to calculate the post-mortem condemnation rate, the pounds of live bird condemnations must be subtracted from the total live birds inspected. Subtracting the 37 million pounds of live bird condemnations from the 12.44 billion pounds of live young chickens leaves about 12.40 billion pounds that were hung on processing lines in 1976. After these birds are slaughtered and blood and feathers are removed, their weight is equivalent to about 11.16 billion pounds of New York-dressed young chickens (90 percent yield). At this stage, the birds are opened and their body contents are examined by Federal inspectors, leading to the post-mortem condemnations.

3/ The study covered all poultry processing and had few breakdowns for broilers only.

4/ Primary treatment is the removal by various screening devices and/or flotation and settling tanks of greases and fine suspended solids from the waste water. The effluent from this is considered raw waste.

In 1976, Federal inspectors condemned (post-mortem) 201 million pounds (New York-dressed weight) of young chickens, 1.7 percent of the young chickens slaughtered. Post-mortem condemnations trended upwards from the early sixties until 1970 and have since trended downwards. Some of the recent reductions in condemnation are undoubtedly due to the development and use of Marek's vaccine, which has reduced the incidence of leukosis since the early seventies.

These reductions in post-mortem condemnation have also led to higher yields in recent years. The 1975 dressed weight yield of 72.8 percent of live weight is the highest ever achieved (table 20).

Spoilage Loss During Storage

No specific information is available on spoilage loss during storage for broilers. However, it is believed to be relatively low because only 732 million pounds (ready-to-cook weight), about 8 percent of the young chickens certified in 1976, were frozen, and peak cold-storage holdings of young chickens in 1976 were 29 million pounds, approximately 4 percent of the birds that were frozen. Thus, the peak amount stored was about 0.03 percent of the amount certified. Losses among cold-storage items are usually relatively small; thus, storage losses for broilers must be very small.

Table 20--Condemnations and yields of young chickens slaughtered under Federal inspection, 1960-76

Year	Ante-mortem	Post-mortem	Yield 1/
		Percent	
1960	0.2	2.5	72.18
1961	.2	1.9	72.52
1962	.2	2.2	72.50
1963	.2	2.4	72.59
1964	.2	2.5	72.55
1965	.2	2.7	72.55
1966	.3	3.7	71.83
1967	.3	4.0	71.62
1968	.3	3.6	71.47
1969	.4	3.5	71.53
1970	.5	4.0	71.41
1971	.4	3.6	71.51
1972	.5	3.1	71.72
1973	.5	2.6	72.05
1974	.4	2.2	72.28
1975	.3	1.7	72.77
1976	.3	1.8	72.43

1/ Total pounds of certified ready-to-cook weight as a percentage of live weight hung on the lines.

Source: Compiled from unpubl. data of U.S. Dept. Agr., Consumer and Mktg. Serv., Poultry Div., and various issues of the Poultry Slaughter Report, Stat. Rpt. Serv.

Processors' Selling Prices

Processors' selling prices trended downward in the early fifties, remained stable in the sixties and the early seventies, and, after rising sharply in 1973, have remained at the higher level. The processors' selling prices trended downward in the fifties and remained low in the sixties for two reasons: farm prices for live birds trended downward in the fifties and remained stable in the sixties (table 1) and, as processors became larger and more efficient, average costs decreased and their margins narrowed. The increase in processor selling price since 1973 reflects a general increase in production and marketing costs of meat products, which has affected the supply responses of competing products and, therefore, resulted in increased prices of competing products.

Pricing methods widely used by processors in the fifties and sixties were summarized in a study by the National Commission on Food Marketing (35, page 55). The general practice through most of this period was to tie the ready-to-cook broiler price to the live price by a formula. A typical formula was the live price divided by 73 percent (the approximate yield of ready-to-cook broiler from live weight) plus 5 to 7 cents to cover processing costs. The live price used was reported by USDA's Market News Service for one of the important Southern broiler-producing States. The resulting ready-to-cook price was used in beginning negotiations with buyers. The price-basing point typically used at that time was Atlanta, and incremental amounts were added to the price to cover transportation costs to various locations. As more and more broilers were produced under contract, there were fewer and fewer actual sales of live broilers to quote. Thus, the Market News Service changed the name of the quotation to "Live At-Farm Base Valuation" and based this value on the information gathered from processors. Finally, on October 1, 1965, the Market News Service discontinued the report entirely and began expanding its coverage of ready-to-cook market prices in large metropolitan areas. This change left the broiler processor without the live-price quotation needed for the traditional pricing formula. At the request of some broiler industry groups, some State departments of agriculture began live-price reporting services to take the place of the discontinued USDA report.

In recent years, the Market News Service developed a 9-City Weighted Average Price for ready-to-cook ice-packed broilers delivered to consuming markets for truck-lot sales. The prices are published on Monday for deliveries to be made in the current week. Trading level used is "delivered to first receiver" at terminal markets. The nine cities are Chicago, Cleveland, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, and San Francisco.

Another recent development by the Market News Service in cooperation with the broiler industry has been the processor's f.o.b. dock-equivalent price for ready-to-cook broilers. The dressed birds--plant Grade A and U.S. Grade A--are ice-packed, in truck lots, for delivery to major markets. Daily reports reflect numbers of loads of whole birds sold at each price level since the last report for deliveries to terminal markets during the current week and for the next week. Also, the cumulative number of loads at each price for delivery in the next week are shown. Processor's f.o.b. dock-equivalent prices are reported for Alabama and Mississippi.

Some State departments of Agriculture also publish processor's f.o.b. dock-equivalent prices. In 1976, Georgia, and Del Marva (Delaware, Maryland, and Virginia) reported processors' f.o.b. dock-equivalent prices.

Price premiums exist in many markets for broilers from nearby areas, or because of size differences, types of packs, and types of outlets serviced. Packing of broilers under processor's brands has been increasing rapidly over the last decade. Based on data in a recent industry survey, about 40 percent of the broilers are branded, more than double the proportion in the sixties. Some brands are consistently sold for premium prices (12).

Geographical Movements

The initial step in developing estimates of geographic movements between producing and consuming areas is to develop a surplus-deficit table. This is done by first assuming that per capita consumption is the same in all parts of the country. An estimate of requirements for each State can then be obtained by multiplying the number of people in the State by the U.S. average per capita consumption figure. This estimate can then be compared with the pounds of broilers produced, State-by-State. The difference between estimated consumption and production is the surplus or shortage.

The States with the largest broiler shortages in 1975 were New York, California, Illinois, Ohio, Michigan, New Jersey, Pennsylvania, and Massachusetts (table 21). For all these States, except Pennsylvania, the shortages of broilers were greater in 1975 than in 1966.

The States with the largest surpluses in 1975 were Arkansas, Georgia, Alabama, North Carolina, Mississippi, Maryland, Delaware, Maine, and Virginia. For all these States, except Georgia, the surpluses of broilers were greater in 1975 then in 1966. Although California and Texas were each one of the ten leading States in broiler produciton, California had the second largest deficit and Texas had a slight deficit in 1975.

Origins of receipts at a sample of 13 cities also help to identify broiler movements. The origins of receipts to these major cities are listed in order of importance. However, competition among producing areas for the markets is also apparent (table 22).

Authors of a recent report use the surplus-deficit estimates, the origin of receipts, and other data to estimate interregional movements of poultry and eggs for 1955-75 (46). The estimated movements of broilers for 1975 are presented in table 23.

Only the South Atlantic and South Central regions have large surpluses in broiler production. While the Mid-Atlantic region produces a surplus of further-processed broilers, the aggregate movements of further-processed broilers from all regions is small compared to movements in ready-to-cook form. Some interregional movements of ready-to-cook broilers occur despite surplus-deficit positions. The principal interregional movements of ready-to-cook broilers are from the South Atlantic region to the Midwest and Northeast, and from the South Central region to the Midwest, Mountain, and Pacific regions, and from New England to the Mid-Atlantic region.

The interregional movements data can be used to estimate the total transportation cost by multiplying the volumes moved by the transportation rates. Nearly 78 percent of the resulting total transportation cost was accounted for by interregional movements. However, interregional movements accounted for only about 55 percent of the volume moved.

Estimated transportation costs for 1975 for movements from northern Georgia to various destinations are presented in table 24. In general, these costs showed an increase of approximately 0.5 cent per pound for most destinations when compared to the 1968 rates. However, the increases varied from 0.35 cent to 1.25 cents per pound.

Table 21--Broiler surpluses and shortages by State and region, 1970-75 1/

State and region	1970	1971	1972	1973	1974	1975
			Million pounds			
Maine	187,005	179,935	175,892	183,930	188,234	193,522
New Hampshire	-27,779	-28,048	-30,177	-29,968	-30,453	-29,728
Vermont	-16,735	-16,799	-17,935	-17,588	-17,714	-17,117
Massachusetts	-207,815	-210,560	-225,978	-218,873	-218,599	-211,800
Rhode Island	-35,604	-35,485	-37,780	-36,498	-35,315	-33,689
Connecticut	-96,653	-100,458	-110,479	-108,196	-110,986	-109,430
New England	-197,580	-211,414	-246,457	-227,194	-224,833	-208,241
New York	-677,457	-673,336	-711,233	-683,052	-678,059	-653,551
New Jersey	-262,291	-267,882	-284,011	-274,011	-274,234	-265,876
Pennsylvania	-291,695	-271,295	-292,861	-271,287	-263,332	-241,511
Mid-Atlantic	-1,231,442	-1,212,513	-1,288,104	-1,228,350	-1,215,625	-1,160,937
Ohio	-373,329	-371,894	-382,285	-367,126	-371,343	-345,613
Indiana	-159,370	-169,096	-170,791	-164,891	-172,263	-161,244
Illinois	-416,947	-412,758	-438,387	-421,819	-419,522	-405,028
Michigan	-329,899	-328,986	-349,333	-339,958	-340,839	-330,965
Wisconsin	-122,705	-122,481	-136,729	-127,671	-138,936	-135,741
East North Central	-1,402,249	-1,406,215	-1,477,524	-1,421,464	-1,442,902	-1,378,589
Minnesota	-113,106	-110,602	-117,753	-112,365	-115,067	-111,669
Iowa	-91,683	-92,984	-95,598	-87,572	-88,619	-87,280
Missouri	-114,337	-110,544	-122,625	-122,487	-125,985	-111,085
North Dakota	-23,137	-23,237	-24,719	-23,967	-24,008	-23,077
South Dakota	-24,934	-24,939	-26,512	-25,741	-25,704	-24,821
Nebraska	-52,607	-52,528	-55,062	-51,491	-51,680	-51,380
Kansas	-81,855	-81,779	-86,916	-83,624	-83,425	-80,767
West North Central	-501,659	-496,614	-529,185	-507,247	-514,489	-490,078
Delaware	350,546	323,822	339,677	374,425	389,964	350,096
Maryland	364,898	346,828	328,647	368,545	377,031	353,206
Washington, D.C.	-28,191	-27,863	-29,319	-27,704	-27,250	-26,021
Virginia	-4,440	5,433	9,901	17,718	15,075	20,379
West Virginia	-21,300	-25,692	-30,695	-29,814	-27,795	-30,222
North Carolina	610,942	582,550	624,686	595,509	600,455	575,306
South Carolina	-29,211	-28,166	-35,186	-31,882	-29,813	-37,345
Georgia	942,794	917,421	968,812	891,430	921,865	897,360
Florida	-138,563	-137,103	-138,927	-140,631	-145,990	-132,959
South Atlantic	2,047,474	1,957,229	2,037,592	2,017,595	2,073,539	1,969,799
Kentucky	-102,168	-102,313	-109,489	-106,288	-106,276	-104,971
Tennessee	-33,613	-23,167	-19,516	-33,237	-51,256	-108,177
Alabama	794,815	815,315	874,275	875,887	869,186	891,221
Mississippi	543,201	543,041	579,317	534,006	501,072	512,362
East South Central	1,202,235	1,232,876	1,324,587	1,270,368	1,212,726	1,190,435
Arkansas	1,003,704	1,097,692	1,232,416	1,156,901	1,138,264	1,100,863
Louisiana	-7,300	3,440	-525	-8,825	-4,629	-6,875
Oklahoma	-47,155	-47,557	-48,187	-40,936	-23,450	-26,234
Texas	47,506	11,141	12,394	4,027	7,713	-24,163
West South Central	996,755	1,064,716	1,196,098	1,111,167	1,117,898	1,043,591
Montana	-26,094	-26,272	-27,916	-27,553	-27,702	-27,184
Idaho	-8,643	-7,032	-22,673	-29,289	-30,114	-29,800
Wyoming	-12,504	-12,544	-13,490	-13,323	-13,531	-13,592
Colorado	-83,299	-84,254	-92,169	-93,150	-94,073	-92,090
New Mexico	-38,112	-38,667	-41,952	-41,480	-42,288	41,684
Arizona	-67,089	-68,898	-76,535	-78,242	-81,146	-80,824
Utah	-36,804	-40,517	-43,940	-43,405	-44,210	-43,828
Nevada	-18,457	-18,871	-20,781	-20,797	-21,596	-21,514
Mountain	-291,003	-297,054	-339,455	-347,238	-354,658	-350,516
Washington	-70,002	-86,483	-88,263	-81,354	-82,980	-87,304
Oregon	-39,218	-44,469	-47,751	-46,385	-46,483	-46,000
California	-513,308	-500,059	-541,538	-539,897	-522,193	-482,164
Pacific	-622,529	-631,010	-677,551	-667,636	-651,657	-615,468

1/ Minus figures indicate shortages.

Table 22--Origin of receipts of broilers for 13 major cities, 1975

City	Origin	City	Origin
Boston	Delmarva Peninsula, New England, North Carolina	Minneapolis-St. Paul	Alabama, Georgia, Missouri, Arkansas
New York	Delmarva Peninsula, North Carolina, New England, Georgia	St. Louis	Georgia, Missouri, Arkansas
Baltimore	North Carolina, Delmarva Peninsula, Georgia	Atlanta	Georgia, North Carolina
Washington, D.C.	North Carolina, Virginia, Delmarva Peninsula	Denver	Arkansas, Missouri, Georgia
Cleveland	Georgia, Missouri, Arkansas, Ohio, North Carolina	Los Angeles	Missouri, Arkansas, California, Georgia
Chicago	Georgia, Missouri, Arkansas	San Francisco	California, Missouri, Arkansas, Georgia
		Seattle	Washington, Arkansas, California

Source: U.S. Dept. Agr., Agr. Mktg. Serv., Poultry Div., Poultry Market News Branch, field offices.

Marketing Channels

An increasingly greater volume of broilers moved directly from processing plants to many types of outlets during the sixties, bypassing traditional wholesale distributors to a greater extent. In the early sixties, the volume moving directly to retail stores, warehouses, and institutional outlets was approximately equal to that moving through traditional wholesalers to such outlets (45). In 1969, about two-thirds of the volume moved directly to retail stores and warehouses and one-third went through traditional wholesalers (18). However, recent data indicates that all types of wholesalers may have become more important in recent years and that there has been a growth in company-owned wholesaling. Figure 4 indicates that less than 50 percent of the volume moved directly to retailers and institutional outlets in 1975. However, it should be noted that processor and retailer owned or controlled distributors are included in the wholesale distributor category.

In the early sixties, institutional outlets accounted for 12 percent of the broiler volume sold other than that for further processing, export, and the military (45). By 1969, institutional use had increased to 25 percent and has remained at about that level since then (13). The major reason for the growth in institutional use has been the spread of fast-food outlets, which accounted for about two-thirds of the institutional use in 1975.

A recent survey of broiler processing plants found that they marketed their broilers through the various types of outlets in different proportions on the west coast than in the South and Northeast. The major differences are the varying proportions moving through distributors and retailers on the West Coast compared with the other two regions (table 25).

Table 23--Young chickens: Interregional movements in ready-to-cook and further-processed forms, 1975

Origin and product form	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	South Central	Mountain	Pacific
	Million pounds, ready-to-cook weight equivalent							
New England:								
Ready-to-cook	158.0	65.9	--	--	--	--	--	--
Processed	11.2	--	--	--	--	--	--	--
Middle Atlantic:								
Ready-to-cook	--	179.7	--	--	--	--	--	--
Processed	15.0	13.5	14.3	--	--	--	--	--
East North Central:								
Ready-to-cook	--	--	102.9	--	--	--	--	--
Processed	--	--	7.7	--	--	--	--	--
West North Central:								
Ready-to-cook	--	--	--	108.3	--	--	--	--
Processed	--	--	--	8.2	--	--	--	--
South Atlantic:								
Ready-to-cook	258.0	1/1,124.4	427.7	1/101.6	1,149.7	--	--	--
Processed	1.1	--	45.4	11.6	75.6	--	--	--
South Central:								
Ready-to-cook	--	--	1/891.2	1/375.0	--	1,173.1	1/329.7	576.9
Processed	--	--	--	1.8	--	77.1	20.8	38.6
Mountain:								
Ready-to-cook	--	--	--	--	--	--	--	--
Processed	--	--	--	--	--	--	--	--
Pacific:								
Ready-to-cook	--	--	--	--	--	--	--	344.4
Processed	--	--	--	--	--	--	--	21.9

1/ Includes young chickens for further processing within the region of destination.

Source: (46)

Table 24--Transportation costs for truckload lots of ready-to-cook broilers from north Georgia plants to various destinations, May 1975 1/

City	Costs per pound	City	Costs per pound
	Cents		Cents
New York City	2.00	Milwaukee	1.75
Philadelphia	1.75	Minneapolis	2.00
Baltimore	1.50	Kansas City	1.60
Washington, D.C.	1.50	Des Moines	1.60
Tampa	1.25	St. Louis	1.50
Miami	1.50	Denver	3.00
Cincinnati	1.50	Los Angeles	3.50
Cleveland	1.75	San Francisco	3.75
Detroit	1.75	Seattle	4.00
Chicago	1.75		

1/ Truckload lots are customarily 400 boxes weighing a total of 30,000 pounds or more without the ice.

Source: U.S. Dept. Agr., Agr. Mktg. Serv., Poultry Div., Mkt. News Br.

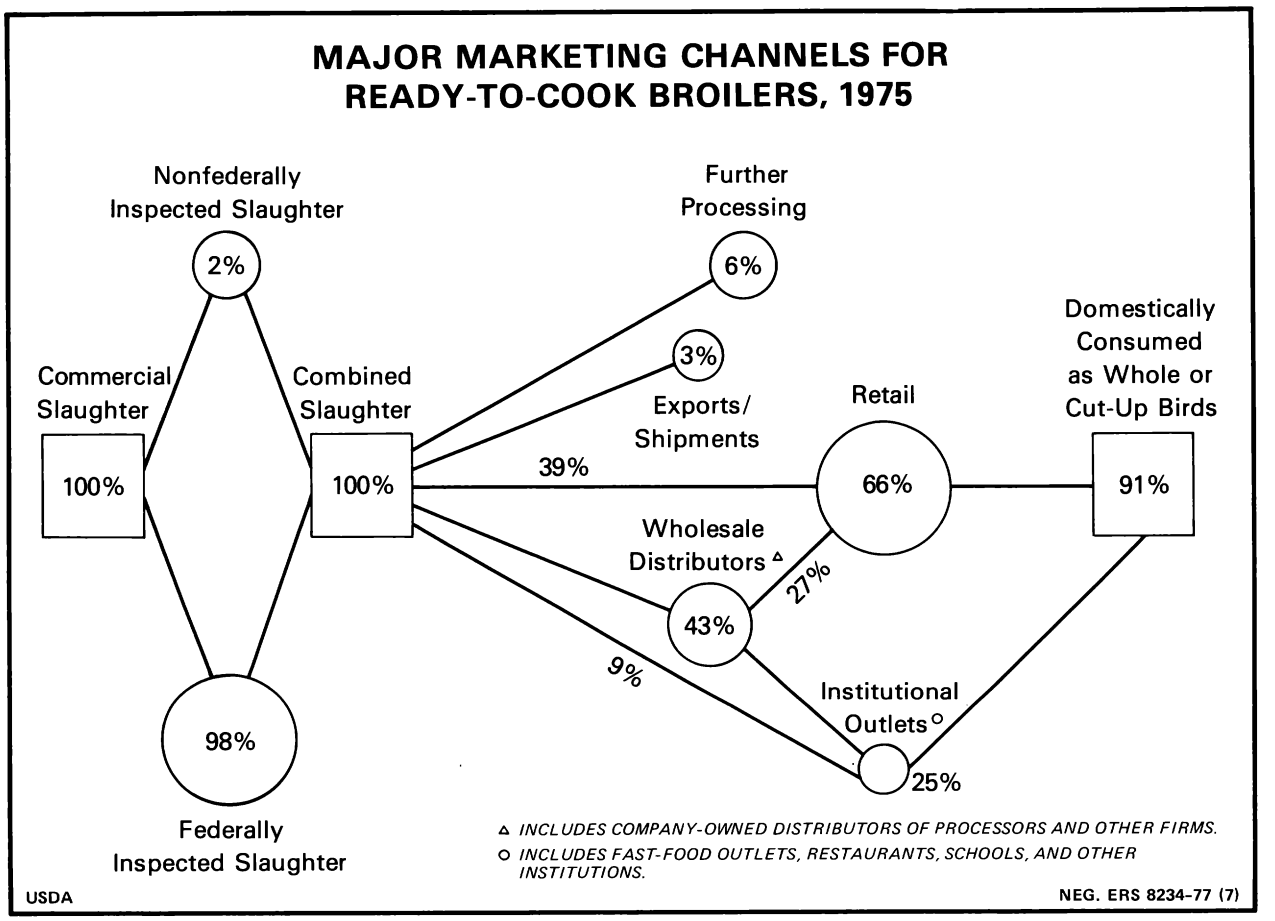


Figure 4

Table 25--Marketing outlets of sample processing plants, by region

Outlets	South 1974	Northeast 1974	West coast 1973-75	Average
	Percent of volume			
Distributors 1/	53	55	19	47
Retailers 1/	31	30	65	37
Institutions	9	6	11	9
Export	3	3	1	2
Processing	4	6	4	3

1/ May include company-owned distributors of processors and other firms.

Table 26--Per capita consumption of broilers by quarters, 1960-76

Period	Quarter				Annual
	First	Second	Third	Fourth	
	Pounds				
1960-62	5.3	6.9	6.9	5.8	24.9
1963-65	6.4	7.4	7.6	6.6	28.0
1966-68	7.5	8.5	8.8	7.9	32.7
1969-71	8.4	9.4	9.5	8.8	36.1
1972-74	9.1	9.9	9.7	9.0	37.7
1975	8.5	9.6	9.6	9.2	36.9
1976	9.7	10.4	10.6	9.7	40.4

Table 27--Prices and price spreads for ready-to-cook frying chickens in 12 cities, 1970-76

Items	1970	1971	1972	1973	1974	1975	1976	1970-76 average
	Cents							
Farm value	17.7	19.0	19.6	34.1	30.6	36.1	31.2	26.9
Price to retailers	30.5	31.6	33.0	46.8	42.1	49.2	45.5	39.8
Retail prices	41.6	41.9	42.6	60.5	57.7	64.2	61.2	52.8
Spreads:								
Farm-retail	23.9	22.9	23.0	26.4	27.1	28.1	30.0	25.9
Farm-retailer	12.8	12.6	13.4	12.7	11.5	13.1	14.3	12.9
Retailer-consumer	11.1	10.3	9.6	13.7	15.6	15.0	15.7	13.0
	Percent							
Farm share of retail prices	42.5	45.4	46.0	56.4	53.0	56.2	51.0	50.9

A recent article in Broiler Industry (9) estimated that in 1975 institutional and food service outlets accounted for $2,333 million in retail sales and that retail chains and small retail stores accounted for $3,381 million in retail sales. Thus, institutional outlets accounted for about a quarter of the broiler volume and for about 40 percent of the retail dollar value.

Further processing, military requirements, and exports combined accounted for about 6 percent of the volume in the early sixties and over 9 percent in 1975. The percentages of volume used in further processing and exports increased from 1969 to 1975.

Seasonality

The seasonal variation of broiler slaughter was discussed in the section on processing. Consumption also varies seasonally. Domestic consumption is highest during the second and third quarters of the year and lowest during the first and fourth quarters (table 26). The two major outlets other than household and institutional use are further processing and exports. Seasonal variation for these seems to follow the seasonal variation of broiler slaughter.

The price freeze of 1973 and inflationary increases in costs and prices have caused departures from past patterns of seasonal variation in farm and retail prices. In the past, when slaughter was highest, the price per pound was the lowest. This pattern may return in the future although in the early seventies there were numerous exceptions. The farm-to-retail price spreads also responded to the general inflation in the seventies. Price spreads widened as the decade progressed, reflecting the increased costs of marketing. Thus, it was difficult to detect usual seasonal variations in price spreads.

Marketing Margins and Costs

Farm value of frying chickens varied from 17.7 to 36.1 cents per pound during 1970-76, while retail prices for major cities varied from 41.6 to 64.2 cents per pound. 5/ The farm-to-retailer margin during the period varied from 11.5 to 13.4 cents per pound. The retailer-to-consumer margin also remained stable from 1970 to 1972, but widened since 1973 (table 27). The farmers' share of the consumer's dollar increased from 42.5 percent in 1970 to a high of 56.4 percent in 1973, and narrowed to 51.0 percent in 1976. This increase has often offset the increases in feed costs that have occurred since 1973.

Prices to retailers for frying chickens generally reflect added costs of transportation and handling as distance from major surplus areas increases. Retail prices may vary between cities because of differing retailer pricing policies and the varying extent of "specialing" in different cities. The use of broilers as a price special is a common practice. Specialing may disrupt orderly producing and marketing arrangements, or serve as a means of reducing buildups in supply. At the same time, it may increase total annual sales, since several times as many pounds are sold in "special" weeks as in "non special" weeks.

A recent study divided the marketing margin for broilers into proportions of broiler marketing costs, by function and cost items, for 1955-74 (43). The cost category breakdown for wholesaling and retailing is presented in table 28.

5/ Farm value is payment received by farmers for a quantity of live poultry equivalent to a pound of ready-to-cook poultry.

Table 28--Proportions of broiler marketing costs by functions and cost items, selected periods, 1955-74

Function and cost item	1955-59	1960-64	1965-69	1970-73	1974 1/
			Percent		
Wholesaling:					
Wages, salaries, fringe benefits	44.9	49.1	54.5	67.1	67.0
Containers, materials	8.5	8.3	7.0	4.1	4.6
Energy	18.2	16.1	13.6	10.1	10.5
Overhead	13.6	12.4	11.7	7.5	7.5
Other	14.8	14.1	13.2	11.2	10.4
Total	100.0	100.0	100.0	100.0	100.0
Retailing:					
Wages, salaries, fringe benefits	38.4	42.1	46.0	56.6	62.0
Containers, materials	6.9	6.2	4.8	4.0	4.2
Energy	3.0	3.4	3.3	3.2	4.8
Overhead	37.6	33.9	32.1	24.8	20.3
Other	14.8	14.1	13.2	11.2	10.4
Total	100.0	100.0	100.0	100.0	100.0

1/ Preliminary.

Source: (43)

Wholesaling

Average costs per unit for wholesaling broilers have consistently risen since the mid-fifties. Until recently, the rate of increase in cost per unit was relatively small and lower than the rate of increase in factor prices. This situation was largely due to relative changes in the kinds of wholesaling operations being performed. As marketing channels have become more direct, a higher proportion of volume has gone directly from the processor to retail warehouses and stores, bypassing traditional wholesalers. These changes offset slower city travel time due to urban congestion and also factor price increases until they rose sharply in recent years.

Total productivity in wholesaling has risen since the fifties. The rate of increase has been much more modest for labor, salaries, and fringe benefits than for other categories. Productivity in using containers and materials has risen substantially because of a shift in the packaging function back toward the processing plants. Rates of increase in productivity of energy, overhead, and other costs have largely reflected changes in the wholesaling function.

Since the mid-fifties the proportion of total costs per unit accounted for by labor, salaries, and fringe benefits has increased from 45 percent to 67 percent. There have been cost declines of nearly 4 percent on containers, 7.7 percent on energy, 6.1 percent on overhead, and 4.4 percent on other items during the same period (38).

Retailing

Cost per unit in retailing broilers has increased since the mid-fifties but not so fast as the changes in factor prices. For other functions in the marketing system, there has been a close relationship between directional changes in both price spreads and costs. For retailing, the relationship is not as close, probably due to the year-to-year effects of variable price merchandising (including the degree and level of price specialing).

Since the mid-fifties total productivity in retailing standard products has appeared to have increased, generally at rates similar to the increases for the wholesaling function. The growing importance of large retail outlets has increased overhead productivity since the mid-fifties, and energy productivity since 1965-69 (table 29). Increased productivity in container and material use has resulted from the shift of packaging back to the processing level. Productivity from labor, salaries, and fringe benefits in retailing has improved only modestly over the last 15 years.

Table 29--Productivity in broiler marketing by cost items and functions, selected periods, 1955-74

(1965-69 = 100)

Cost item and function	1955-59	1960-64	1965-69	1970-73	1974 1/
Wages, salaries, fringe benefits:					
Wholesaling	91	95	100	105	113
Retailing	87	99	100	97	105
Containers, materials:					
Wholesaling	82	87	100	188	212
Retailing	69	84	100	126	153
Energy:					
Wholesaling	77	90	100	161	182
Retailing	113	110	100	117	125
Overhead:					
Wholesaling	70	87	100	195	226
Retailing	70	93	100	153	210
Other:					
Wholesaling	92	93	100	134	173
Retailing	102	104	100	130	214
Total:					
Wholesaling	85	93	100	125	139
Retailing	81	97	100	117	141

1/ Preliminary.

Source: (43)

Wages and overhead costs make up, by far, the largest proportion of retailing costs. The relative importance of labor, salaries, and fringe benefit cost, as a share of total cost per unit, has trended upward since the mid-fifties. Overhead costs and, less steadily, container and material costs, have trended downward. Energy costs have remained steady or increased as a share of total cost. The share for other costs has been variable to lower. Retail cost component data are based on fragmentary observations and are thus not represented as being as accurate as those for other functions.

Time Lapse in Marketing

To illustrate the time lapse in marketing, a shipment of ice-packed broilers is traced from a northern Georgia processing plant to a consumer in Chicago. Live birds are hung on the processing line directly from trucks beginning on Monday morning. By Monday afternoon or evening, the birds have been processed ready-to-cook, chilled, ice-packed, and loaded into a large truck carrying a net weight of at least 30,000 pounds. With one driver on the truck, the load arrives at a chain store warehouse or wholesale distributors' warehouse in Chicago on Wednesday morning. The birds are distributed to retail stores and other outlets on Wednesday and Thursday. The last lots distributed may be re-iced. Some birds are then cut up, packaged, price marked, and date coded in the meat room of the retail store. Other birds are packaged to be sold whole. They are displayed on retail counters on Friday and Saturday. The consumer buys them on Friday or Saturday and cooks the birds on Sunday. In the example given, the time span was 7 days from slaughter to consumption. This can be shorter or longer depending on the marketing conditions.

Tighter scheduling throughout the processing and marketing system can reduce the time lapse substantially. For instance, the birds may be cut up, packaged, price marked, and date coded at the processing plant. Also, transit time can be sharply reduced by using two drivers instead of one (table 30).

Table 30--Transit time from north Georgia plants to various destinations for truckload lots of ready-to-cook broilers, 1975

Destination	One driver	Two drivers
	Hours	
New York City	40	18
Tampa	18	NA
Miami	24	12
Cincinnati	18	NA
Cleveland	36	18
Detroit	40	20
Chicago	36	18
Milwaukee	36	18
Minneapolis	40	30
Des Moines	36	18
St. Louis	18	NA

NA = Not available.

Quality Preservation

Controlling reduced product temperature, both at the processing plant and during marketing and distribution, is of primary importance for quality preservation. Immediately after processing, the internal body temperature of the birds must be brought to 40°F (4.4°C) or below to control the growth of micro-organisms (52). This can be achieved through ice and water chilling, air chilling, or freezing.

In 1975, approximately 55 percent of the broiler poundage certified was ice-packed, 25 percent was chill-packed, and 14 percent was packed in carbon dioxide (CO_2) (11).

A recent survey of 37 broiler processing plants found some regional variation from these estimates as follows:

Type of pack	South 1974	Northeast 1974	West Coast 1973-75	Average
	Percent			
Ice packed 1/	57	75	44	59
Deep chill	22	15	43	24
CO_2 1/	13	5	12	11
Frozen	8	5	1	6

1/ May include small amounts of combination packs.

Ice packing, the most widely used method, uses a slurry of ice and water in which the birds are tumbled or agitated. Birds under 4 pounds must be chilled to less than 40°F in less than 4 hours from time of slaughter. Currently, this is done in less than 1 hour. Water absorption of 10-12 percent results, depending on (1) how long the birds are kept in the ice and water and (2) how they are tumbled and agitated. Before packaging, the birds are hung on a drip line and some of the water is lost. USDA regulations specify moisture absorption of no greater than 12 percent at the time of packaging. Additional amounts are lost during transportation and handling.

Chlorine can be used in the ice slurry. The effect of a concentration of available chlorine of 200 ppm was found to increase shelf life at 1°C by about 20 percent, or one day, with no significant effects on appearance, taste, or odor. Apparently the chlorine removes the salmonellae from the skin surface but not that embedded in the skin or hair follicles. Concentrations of 500 ppm or more resulted in tainted carcasses (37).

Ice-packed broilers are usually packed 24 to the box and then covered with 20 pounds of ice. Some buyers specify that 20 birds be packed per box in the summer so that more ice can be included. Others may specify a 60-pound net weight of broilers to facilitate easier billing from the warehouse to the store. Generally, the entire truckload is iced between the top layer of boxes and the roof of the truck.

Birds being chill-packed are first chilled in an ice water slurry but are not agitated, thus minimizing water absorption. Absorption is about 5 percent compared to about 12 percent in conventional chilling. Next, the birds are hung on a conveyor and moved through a 43°F (6.1°C) cooler for 45 minutes, providing a longer draining time than that for ice packed birds. Then they are put through a blast freezer at -40°F (-40°C) and kept there for 45 minutes, long enough to pull the internal body temperature down to 28°F (-2.2°C). The birds are then kept at 28°F and may be cut, wrapped, weighed, priced, and dated at the processing plant. Plants that have successfully

used the patented chill-pack process have done so by (1) using a high degree of sanitation in the processing plant to minimize initial bacterial populations and (2) bringing the body temperature down to 28-32°F and holding it there during distribution and retailing (12). Chill packs also provide greater payloads than ice packs and less storage space is needed for dry cartons.

Retailers may often pay more per pound for chill-packed than for ice-packed broilers. Increased costs may be partially offset by savings in labor, reduced moisture loss, packaging, rewrapping, and spoilage at the retail store. Less tangible benefits are the handling of a dry product, a reduction in box disposal, and an increase in the time butchers have for other duties such as stocking red meat counters. Because of these savings, plus price competition, there may often be little price difference at the retail level.

Disadvantages of the chill-pack system are high initial investment in the equipment and rigid requirements for controlling low product temperature during marketing.

In the CO_2 pack, carbon dioxide gas is injected into a carton, where it supercools the box and then falls to the bottom as CO_2 ice. A pad is put on top of this and the poultry placed in the box. After this, the birds may be top-coated with CO_2 ice and are then handled the same as the ice-packed birds.

The advantages claimed for this patented system are: (1) a payload 25 percent greater than that from ice packing, (2) no short-weight problems, (3) a more sanitary package, and (4) at least 20 percent fewer cartons and less storage space needed for dry cartons.

A new packaging process packs the chilled birds in a heat-sealed, CO_2 gas-filled plastic bag within the carton (10). The CO_2 retards bacterial growth and has significantly increased shelf life. In addition, no ice is required, so greater payloads are achieved.

About 7 percent of the pounds of broilers certified as wholesome in 1975 were frozen. Freezing preserves broilers for long periods while chilling is used for periods of 7 to 21 days. Frozen broilers can be cut up, packaged, and frozen at the processing plant for regular accounts, institutions, and other outlets that want a frozen product. Frozen broilers are usually moved into and out of the warehouses on a 3-month rotation, and very few, if any, are put into storage because of low prices or slack demand.

Shelf Life of Broilers

Shelf life is a concept that involves time and means different things to different groups of people. Retailers think of shelf life as the length of time from arrival of the food product in their store to the point where it is no longer sound, healthful, clean, and otherwise fit for human consumption. This amount of time varies, depending on several factors, but the most important appear to be (1) initial bacterial populations, (2) proportions of the initial bacteria that are spoilage types, and (3) storage temperatures (61, 48). Short shelf life is associated with relatively high initial bacterial counts, especially spoilage types; variable temperatures; and poor handling and sanitary practices during marketing. Conversely, longer shelf life is associated with low initial bacterial counts, strict temperature control, and good handling and sanitary practices. The lower the temperature the better, and the more consistent the low temperature the better. A constant low product temperature maintains product quality for a longer shelf life.

In some experiments, ice-packed broilers were stored for as long as 13 days. However, a shelf life of about 7 days is used in commercial practice and represents the maximum time allowable between slaughter at the processing plant and purchase by the consumer in the retail store.

Shelf life for CO_2-packed broilers is about equivalent to that for ice-packed birds. However, chill-packed birds, when handled under proper temperature control, have a shelf life of 10 days or more. The new CO_2 packs have experienced shelf lives of 15 to 18 days (10).

Irradiation Preservation

Preservation of broilers by ionizing irradiation (gamma rays) is still in the experimental stage, but it may be feasible in the future. It offers the advantage of control of salmonellae and other micro-organisms, and longer shelf life. Three dosage levels of ionizing irradiation have been established. The lowest level, radurization, is defined as an irradiation process that reduces the number of spoilage micro-organisms and results in an increase in refrigerated storage time. The second level, radicidiation, is defined as an irradiation process that reduces or eliminates specific organisms of public health significance. The third, and the highest level, radappertization, is defined as a process that commercially sterilizes the product (destroys micro-organisms in the food) (63). Experiments have been conducted with poultry meat at each of these levels.

One recent experiment used two different levels of irradiation, 250 and 500 krad. 6/ This experiment found that irradiation at the 250 krad level and storage at 1.6° C inhibited bacterial multiplication for 18 to 22 days. At that point, the irradiated poultry meat had a bacterial count equal to the initial bacterial count of the nonirradiated control poultry meat. The poultry meat subjected to the 500 krad dose did not reach that bacterial level for over 31 days. Both irradiation levels eliminated all organisms of public health significance. Poultry meat in this experiment was oven-roasted and the white and dark meat were evaluated separately. All samples were found to be acceptable, with the 250 krad samples being slightly superior to the 500 krad samples. Although the roasted chicken was acceptable after 22-31 days of storage, the appearance of the unroasted carcass was considered borderline for consumer acceptance. Thus, the irradiation process could lengthen the shelf life of chickens from approximately 8 days to at least 15 to 18 days (27).

There are some disadvantages to irradiating broilers. One disadvantage is that the irradiation process at dosages of 500 to 700 krad may produce some off-odors and off-flavors that some people find objectionable. However, these odors are not present in the chicken after frying or broiling (27). Another is that irradiation may also kill micro-organisms which indicate spoilage and off-condition. The initial investment cost of an irradiation facility is also a problem. However, this may be solved in the future by having a centrally located facility which might service more than one poultry processing plant, or plants producing various food products.

At present, ionizing irradiation of broilers as a commercial practice is not an immediate possibility for a number of reasons. Approval of the Food and Drug Administration must be obtained before it can be used as a process. After this, USDA approval must be obtained because the process is subject to the Poultry Products Inspection Act. Also, commercialization of the process will come slowly because it is new, initial costs are high, and consumers and others generally lack knowledge of the

6/ A krad is 1,000 rads. A rad is the quantity of ionizing radiation which results in the absorption of 100 ergs per gram of irradiated material.

benefits of ionizing irradiation. However, on June 20, 1973, the Canadian health authorities approved the test marketing of eviscerated poultry in plastic bags radicidized (salmonellae irradication) by exposure to gamma rays of cobalt-60 at exposure doses not to exceed 700 krad. Then, in August 1976, the Netherlands cleared radiation processing of poultry at the 300 krad level, and, in September 1976, the World Health Organization cleared radiation processing of poultry at the 700 krad level (25, 59).

CONSUMPTION AND DEMAND

Broiler Consumption

Total consumption of chicken consists of broilers and "other" chickens. In the thirties and forties, other chickens accounted for the bulk of total consumption. 7/ Such chickens then consisted of surplus cockerels and pullets raised for marketing as young birds, plus fowl sold from egg-producing flocks. Most of these chickens were sold frozen because production was highly seasonal. With the development of commercial broiler production, consumers were offered more fresh-killed birds and generally preferred them.

Production of "other" young chickens for market also gradually declined because lighter-weight, market-egg strains were developed and many day-old cockerel chicks were separated out by sexing and then destroyed. "Other" chickens currently marketed consist mainly of fowl or roasters. By the early fifties, consumption of broilers equaled and then surpassed that of other chickens. Consumption of other chickens became relatively stable by 1960, but consumption in 1976 accounted for more than 93 percent of total chicken consumption (table 31).

Demand for Broilers

Various studies have discussed price elasticity, cross elasticities, and income elasticity of demand for broilers. Because of the former predominance of "farm

7/ These were usually called "farm chickens."

Table 31--Per capita consumption of broilers and other chicken, selected years, 1934-76

Year	Broilers	Other chickens	Total chicken	Broilers as share of total chicken consumption
		Pounds		Percent
1934	0.5	13.1	13.5	3.7
1940	2.0	12.1	14.1	14.2
1945	5.0	16.6	21.6	23.1
1950	8.7	11.9	20.6	42.2
1955	13.8	7.5	21.3	64.8
1960	23.3	4.7	28.0	83.2
1965	29.6	3.8	33.4	88.6
1970	36.9	3.6	40.5	91.1
1975	36.9	3.4	40.3	91.6
1976	40.4	2.9	43.3	93.3

chickens" in the chicken meat supply, many earlier studies evaluated the demand for all chickens, in contrast to later studies which were confined to demand for broilers. Coefficients from the various studies varied over a wide range because of the time periods included, the data sources, and the scope and the methodology of the studies.

Price elasticity of demand at the farm, wholesale, or retail levels refers to the percentage change in the quantity of broilers demanded which accompanies a 1-percent change in broiler price. Cross elasticities estimate the percentage change in broiler quantity demanded accompanying a 1-percent change in the price of a competing meat. Income elasticity relates broiler quantity demanded to change in family income. Price elasticities for broilers are generally negative, since quantities and prices are inversely related, while cross- and income-elasticities are generally positive.

A 1970 study compared wholesale broiler prices to broiler quantity, pork quantity, beef quantity, and other chicken quantity, making adjustments for income and population. The derived price elasticity of demand at the mean was -1.053. Table 1 in the appendix presents the coefficients for each of these quantity variables as well as the coefficients for the monthly dummy variables (36).

A more recent analysis of the poultry subsector estimated the retail price elasticity of demand for broilers to be -0.82. However, the poultry subsector model was based on annual data to facilitate its use as part of a model of the entire agricultural sector; thus, it fails to capture the seasonal shifts in either demand or supply (23).

Unpublished results of another demand study indicate that monthly demand at the wholesale price level appears to be considerably more elastic, and quarterly demand is slightly more elastic, than that indicated in the above study (6). One reason higher monthly elasticities might be expected is because the consumption data used in the equations are based on disappearance from marketing channels instead of actual observed consumption. Per capita consumption of broilers, turkeys, beef, and pork is estimated by taking total production and adjusting for cold storage stock holdings, imports, exports, shipments to U.S. territories, and military purchases. This means that purchases by consumers to stock freezers are credited to the current month although consumed later. A rough measure of the extent of this practice is that a retail chain store indicated that the movement of broilers during a week of a price special is about three times that of a week without a price special.

Four alternative equations estimated by the study are presented in table 32. The equations are all price dependent equations. The dependent variable is the wholesale broiler price. The independent variables for all four equations are per capita consumption in pounds of broilers, turkeys, beef, and pork and per capita real disposable income. The actual data series used to estimate the monthly and quarterly equations varied some because not all series are available on a monthly basis. The data for 1973 were deleted from the series used in the monthly equations because price controls were in effect much of that year. The data for 1973 were included in the quarterly equations, but dummy variables for the second and third quarters were used to remove the impact of price controls.

The structure of the first equation is quite similar to those used in previous studies, which used monthly data with monthly demand shifters. Broiler price lagged 1 month was added as a variable in the second equation, and the equation was estimated by an iterative technique to eliminate auto-correlation errors. The regression coefficients, T-values, and monthly broiler price elasticity estimates for these two equations are presented in table 32. The estimated elasticities of equation 1 ranged from -1.64 to -2.18 and the estimated elasticities for equation 2 ranged from -2.57 to -3.34. The lagged price coefficient is a measure of the lagged impact on broiler price. More than half of the price adjustments occur in the first 3 months; therefore, lagged price was not used as a variable in equations 3 and 4.

Table 32--Broiler demand equation at the wholesale price level.

Variable name	Equation No. 1			Equation No. 2			Variable name	Equation No. 3			Equation No. 4		
	Regression coefficient	T-value	Estimated Elasticity	Regression coefficient	T-value	Estimated Elasticity		Regression coefficient	T-value	Estimated Elasticity	Regression coefficient	T-value	Estimated Elasticity
Constant	43.44	NA	NA	8.29	NA	NA	Constant	65.44	NA	NA	71.00	NA	NA
Per capita broiler cons. (lbs.)	-4.92	3.98	NA	-3.14	4.74	NA	Per capita broiler cons. (lbs.)	-3.77	6.69	NA	-3.80	6.60	NA
Per capita beef cons. (lbs.)	1.46	2.93	NA	.90	3.39	NA	Per capita beef cons. (lbs.)	- .75	3.22	NA	- .68	2.89	NA
Per capita pork cons. (lbs.)	-2.94	9.54	NA	- .39	1.63	NA	Per capita pork cons. (lbs.)	- .80	5.01	NA	- .89	5.58	NA
Per capita turkey cons. (lbs.)	.95	.43	NA	-1.20	1.06	NA	Per capita turkey cons. (lbs.)	-3.18	2.61	NA	NA	NA	NA
Deflated per capita personal income ($1,000)	- .46	.39	NA	.60	.96	NA	Per capita disposable income 1972 dollars ($1,000)	10.69	6.28	NA	9.38	5.49	NA
Lagged broiler price (cents)	NA	NA	NA	.76	14.76	NA	4th Quarter per capita turkey cons. (lbs.)	NA	NA	NA	-3.50	2.04	NA
January	Base Period		1.86	Base Period		2.91	1st quarter	-9.12	2.36	-1.00	-13.26	1.91	-1.00
February	-1.27	1.52	2.18	- .96	2.46	3.34	2nd quarter	-6.38	1.75	- .86	-11.24	1.61	- .85
March	.76	1.06	1.97	-1.11	2.80	3.01	3rd quarter	-2.77	1.01	- .87	-10.27	1.46	- .87
April	- .11	.14	1.82	-1.54	3.55	2.84	4th quarter	Base period		- .88	Base period		- .87
May	.46	.55	1.75	.16	.35	2.74		R^2 = 0.88 Durbin-Watson statistic = 1.38			R^2 = 0.88 Durbin-Watson statistic = 1.26		
June	.67	.75	1.74	.36	.75	2.73							
July	.56	.57	1.84	.60	1.14	2.88							
August	.19	.17	1.71	- .65	1.07	2.68							
September	- .63	.52	1.80	- .74	1.17	2.82							
October	- .94	.60	1.64	-1.25	1.55	2.57							
November	-4.01	1.03	2.01	- .18	.90	3.14							
December	-2.81	1.33	1.78	-1.38	1.27	2.79							
	R^2 = 0.69 Durbin-Watson statistic = 0.88			R^2 = 0.93 Durbin-Watson statistic = 2.05									

NA = Not applicable.

Source: (6)

The third equation has basically the same structure as the first equation, except that quarterly data and quarterly demand shifters were used. This equation yielded an estimated price elasticity at the quarterly means that ranged from -0.86 to -1.00.

The fourth equation differs from the third in only one respect. The per capita turkey consumption variable has a value only in the fourth quarter. The first three quarters observations were all set equal to zero. This change was made because per capita turkey consumption was not found to be a significant variable in the first, second, and third quarters in equations which were separately estimated for each quarter. This change did not significantly alter the price elasticity, but it did improve the predictive capability of the equation in 1976.

The above study also developed a technique to estimate regional demand shifters. The regional demand shifters were estimated as follows:

1. Regional per capita consumption was estimated by multiplying the mean U.S. per capita consumption of broilers, turkeys, beef, and pork by regional per capita consumption indices for these products from previous studies (38, 39, and 40).

2. The mean regional per capita income data were estimated from State income data.

3. The mean wholesale price for the region was assumed to be equal to the mean price for a representative city within the region.

4. These estimated regional mean values for per capita broiler, turkey, beef, and pork consumption and per capita income were used as observed independent variables in the U.S. demand equation.

5. The regional demand shifter is then estimated as the residual between the estimated price from the U.S. equation above and the mean city price for the region.

Projections, 1980-85

With continued moderate growth in both consumers' real disposable income and population, the demand for meats will likely continue to grow. Assuming that feedstuffs will be plentiful and no unforseen market interruptions occur, broiler meat production will continue to increase in coming years. Broiler meat output may exceed 9.5 billion pounds in 1980. If the average broiler marketing weight remains around the 3-3/4 pounds of 1974-76, the number of broilers raised in 1980 would total around 3.5 billion.

The Economic Projections and Analytical Systems of the Economic Research Service recently published long-run projections for production and utilization of commodities for 1985 (53). Based on continued moderate growth in consumers' real disposable income, an increased population of 236 million in 1985, and continued growth in U.S. farm exports, total chicken meat production was projected to be around 11.7 billion pounds (ready-to-cook) in 1985. In recent years, broilers' share of total chicken meat production has increased as egg-laying flocks have been reduced. In 1985, broiler meat may account for around 93 percent of the total. This indicates that broiler meat output in 1985 would total around 10.9 billion pounds, about 1.9 billion pounds above the 1976 output. Per capita consumption of broiler meat would be approximately 46.2 pounds in 1985.

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Appendix Table 1--Estimated coefficients for demand model for PBW (Chicago wholesale broiler price by months, 1960-67) regressed on broiler quantity in pounds

Month	R^2	N	Constant term	Regression coefficients 1/						Regression F
				Monthly deviations from overall regressions		Broilers nos/100 people	Pork lbs/100 people	Beef lbs/100 people	Turkey lbs/100 people	Non-broiler chicken lbs/100 people	
				Regular coefficients	Standard errors						
	.65	96	58.0502			-.08392 (.01)	-.0107 (.603)	-.0054 (.004)	-.06216 (.013)	.0388 (.019)	9.195
January				-.4091	(1.3)						
February				-.7348	(3.4)						
March				-1.2066	(2.46)						
April				-.7963	(2.4)						
May				1.082	(2.52)						
June				1.3255	(2.43)						
July				2.4697	(2.37)						
August				.4098	(2.24)						
September				1.8884	(1.99)						
October				-.2993	(1.78)						
November				-1.9173	(1.53)						
December				0	0						

1/ Standard errors of the estimates are shown in parentheses.

Source: (36)

* U. S. GOVERNMENT PRINTING OFFICE : 1977--241-445/ERS-191